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Zeppelins over England

Observation Balloons

Armed Forces of the World: Soviet Air Force (Part 1)

Death of a Zeppelin

A fully illustrated guide to Airships of World War I

WAR MACHINE

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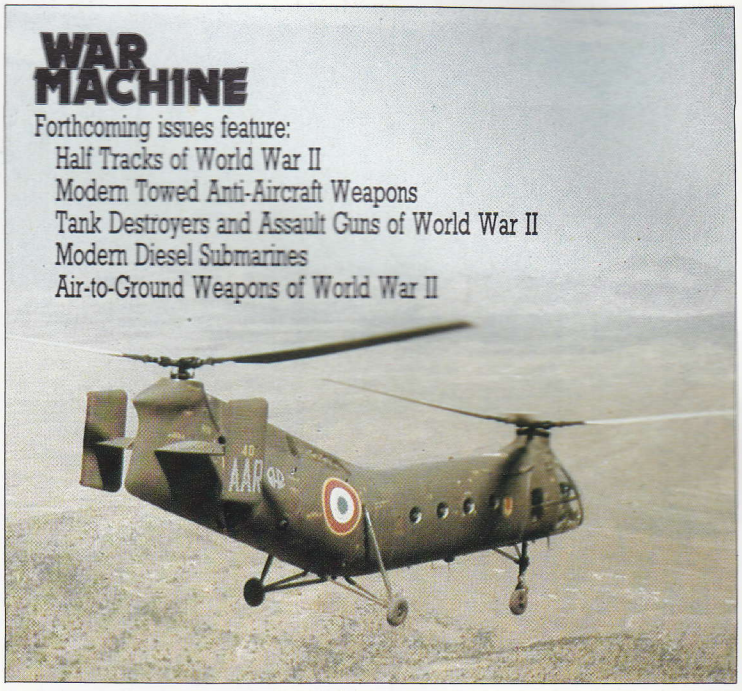

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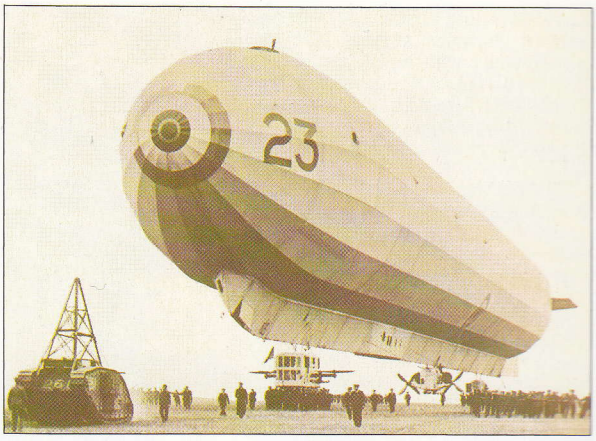
Airships of World War 1

Airships were the first strategic bombers. Able to carry greater bombloads over far longer distances than early aeroplanes, they were soon employed by the Germans to carry the war to Britain itself. Most belligerent nations used airships, mainly for reconnaissance and observation missions, but today it is the raids of the German Zeppelins that are best remembered.



No. 23 was first of a proposed class of 10 British dirigibles, but arguments about the design took so long to resolve that by the time she was completed she was obsolete. In 1918 No. 23 was experimentally fitted with two Sopwith Camels for defence against hostile aircraft.

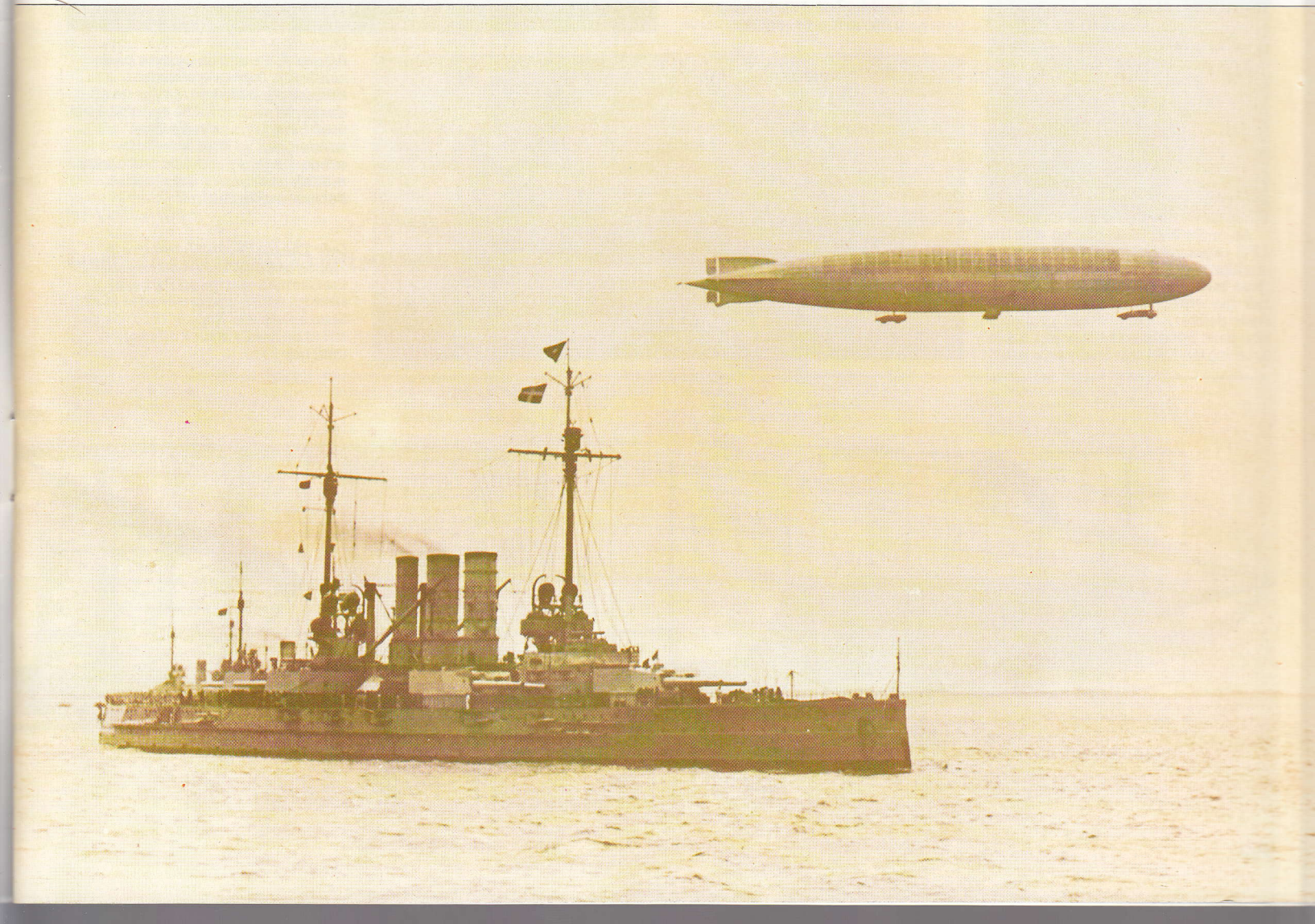
In the days immediately preceding World War I, when aeroplane flight had been possible for only 10 years, there existed a large body of opinion that the future of military flying lay as much with lighter-than-air craft as elsewhere. There seemed to be firm foundations for this since the first attempt to construct a guided balloon (a dirigible) had taken place in 1816.

Following this, there had evolved three types of airship: the non-rigid, which depended on inflation for the shape of its envelope; the semi-rigid, which was similar but with a strengthening keel; and the rigid, with a lattice structure of wood or metal surrounding internal gas cells.

In Germany the last proved especially successful, and the first Zeppelin airship was flown in 1900. The years following had seen certain factions concentrating on its military development, so that there had grown up in the public mind the idea of the bombing airship as the ultimate weapon against which there was virtually no defence.

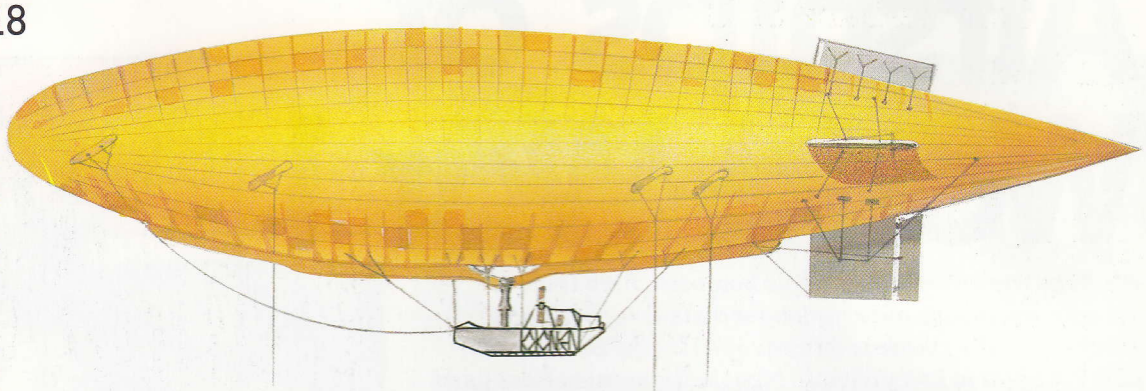
In the UK, France, and later the USA, the tendency to concentrate on the other forms of construction resulted in smaller vessels put to different use. The swift development of a reliable aeroplane broadly altered the whole outlook, although rigid airships of the German pattern continued to attract their supporters even after the Admiralty had abandoned them in 1919. Elsewhere, the US Navy developed the coastal patrol type of smaller airship, even using them in World War II.

L31 flies serenely over the 'Helgoland' class dreadnought SMS Ostfriesland. *The German navy made extensive use of Zeppelins for scouting, but communications problems reduced their theoretical effectiveness. L31 and her crew perished over England at the hands of a B.E.2c in 1916.*



GERMANY

Parseval PL 18



A new non-rigid airship made its first flight in Germany in May 1906: relatively small with a volume of only 2300 m^3 (81,224 cu ft), this airship was of technical interest in that the shape of the envelope was maintained by means of pressurized ballonets fore and aft.

The craft was to the design of former army officer August von Parseval, later a professor at the Berlin Technical Academy, and improved models continued to be produced after their construction was transferred from the Motorluftschiff Studiengesellschaft to the Luftfahrzeug Gesellschaft (LFG) organization in June 1913. In this same year an order was placed by the British government for a single example of the improved type, and **Parseval PL 18** was delivered for use by the Royal Navy where it received the service designation **Naval Airship No. 4 (NA4)**.

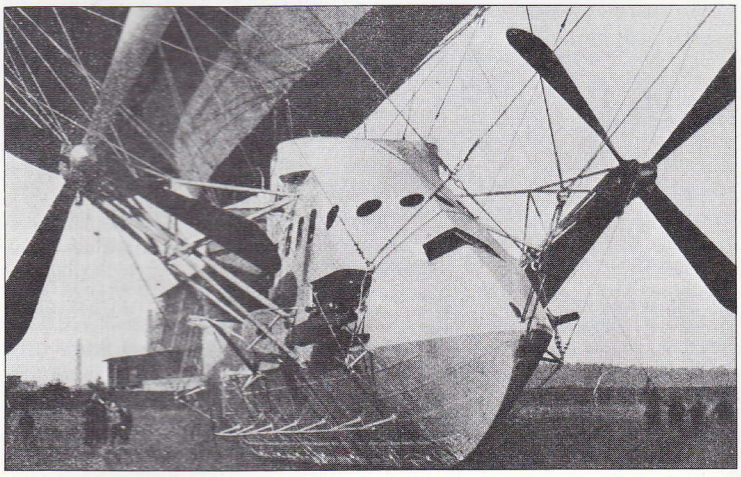
On 5 August 1914 this vessel, by a strange stroke of irony, was the first British aircraft to carry out an active war operation when, flying from its base at Kingsnorth, the first RNAS airship station, it was sent to patrol the Thames Estuary. It was used again on 10 August, this time in company with NA3, the only British airship of the period to be armed, another imported design, an Astra-Torres.

The degree to which Parseval designs had advanced in a short time was evident from the fact that the NA4 was a revised type of vessel, which probably promoted the order for a further three before the war, to be built under licence by Vickers at Barrow-in-Furness. These were given the service designations **NA5, NA6** and **NA7** at the beginning of their career, which was entirely confined to use for the instruction of airship crews.

Meanwhile, the NA4 was still employed on sterner duties, and the first months of World War I found it in use as a submarine hunter, although its effect was entirely psychological, providing cover for the convoys ferrying troops of the British Expeditionary Force between Dover and Calais.

An order had been placed with the LFG organization for a further three airships of similar design which would have been the **PL 19, PL 20** and **PL 21**, but the outbreak of war prevented their delivery. They would probably also have been used for training, a role to which the NA4 was finally relegated, but it is interesting to note that at the time it was in service as a patrol vessel, the German navy had requisitioned the non-rigid PL 6 on 9 August 1914 and also obtained PL 19 on loan on 19 September for sea patrol work over the Baltic from Kiel. This was a duty to which they were well suited, being capable of carrying 590 kg (1,301 lb) of bombs and with a maximum flight time of 11 hours.

Car design and suspension of the British Parseval PL 18 (Naval Airship No. 4) was more rudimentary than that of the licence-built Vickers versions, Nos 5, 6 and 7. They were substitutes for three ordered from Germany but not delivered due to the outbreak of war in August 1914.



Specification

Parseval PL 18

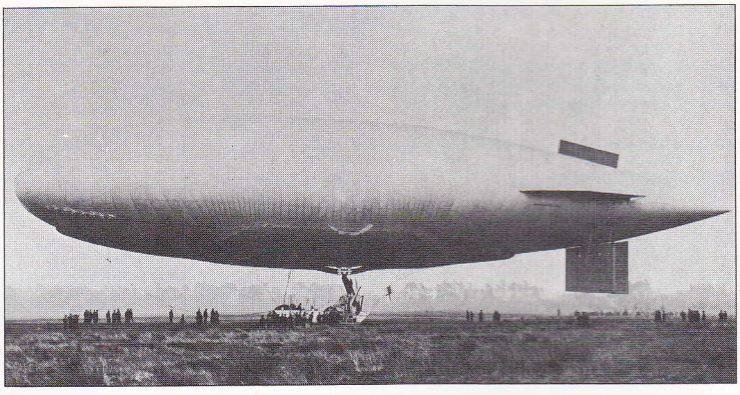
Type: patrol airship

Powerplant: two 134.2-kW (180-hp) Maybach six-cylinder water-cooled piston engines

Performance: maximum speed 72 km/h (45 mph); service ceiling 4000 m (13,123 ft); range 1000 km (621 miles)

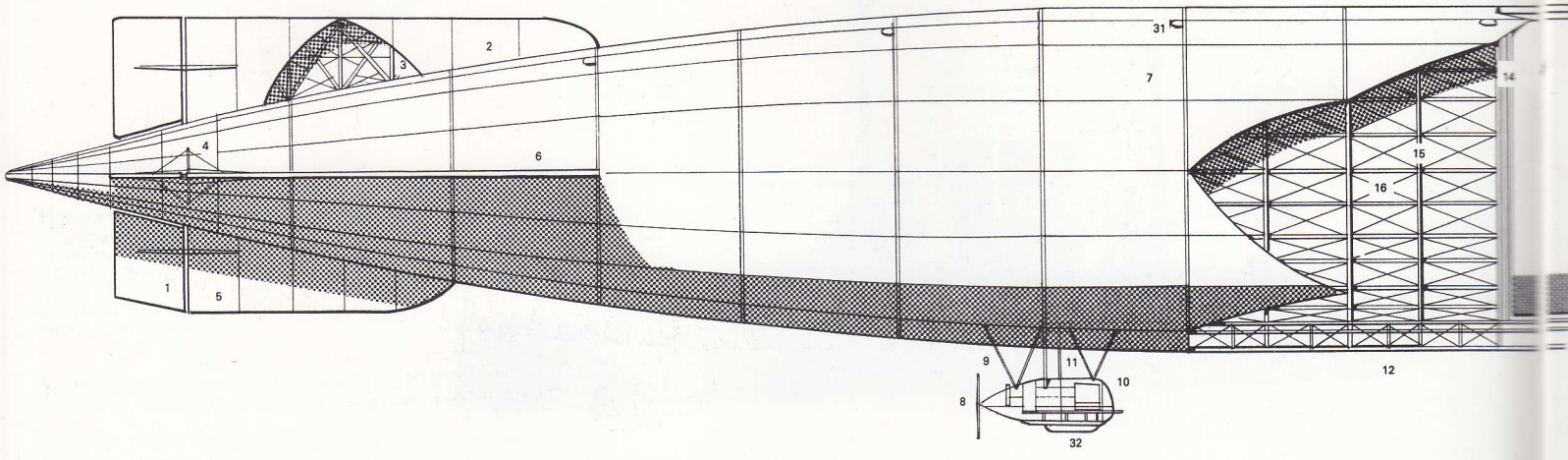
Weight: useful lift not known

Dimensions: diameter 15.50 m (50 ft 10.2 in); length 94.00 m (308 ft 4.8 in); volume 10000 m^3 (353,147 cu ft)



Above: Although enjoying a basic similarity, there were some differences between the Parseval-designed airships. The car of PL 12 is seen here; it was a passenger version, but its lines were to be echoed in those of the three Vickers models built under licence at Barrow-in-Furness.

Left: The first Royal Navy airship station at Kingsnorth was the base of the German-designed Parseval airship, which was ordered in 1912. Seen here on 27 August 1913, it was not to be finally struck off charge until July 1917.



GERMANY

Schütte-Lanz SL11

'A severe shortage of aluminium in Germany had forced her to resort to wood for the construction of her airships.' When **SL11** was brought down by William Leefe Robinson on the night of 3 September 1916 this statement was generally accepted as true, since there was no great metal skeleton to greet the crowds that flocked to Cuffley where the airship fell. In fact wire-braced wooden structures had been used by the Schütte-Lanz company since the design stages of their initial SL1 that had first flown on 17 October 1911.

Conceived from the outset with an alternative construction to rival the metal Zeppelins, the SLs with their rigid ply framework were claimed to be lighter and more flexible than metal-framed airships, and most of those in German military service were operated by the army.

The reason for this is not difficult to discover, because the navy, responsible for most of the raids against the British Isles, rightly claimed that wooden vessels were incapable of lifting a sufficiently large bomb load as their weight would be increased by moisture absorbed while crossing the sea.

SL11 was accepted by the army in June 1916, and after trials was sent to its operational base at Spich in August. At the end of the month its initial operational sortie proved abortive because of the weather, so the attack at the beginning of September was its first and last, such a brief career resulting in the airship having only one commander, Hauptmann Wilhelm Schramm, who had gained experience in charge of three earlier rigids, all of Zeppelin design. On the night of the SL11's destruction, when Schramm died with all his crew, both incendiary and explosive bombs were dropped, but the airship's chief claim to fame now lies in the fact that it was the first enemy aircraft of any kind to be brought down on British soil, in recognition of which Robinson was awarded the Victoria Cross.

Specification

Schütte-Lanz SL11

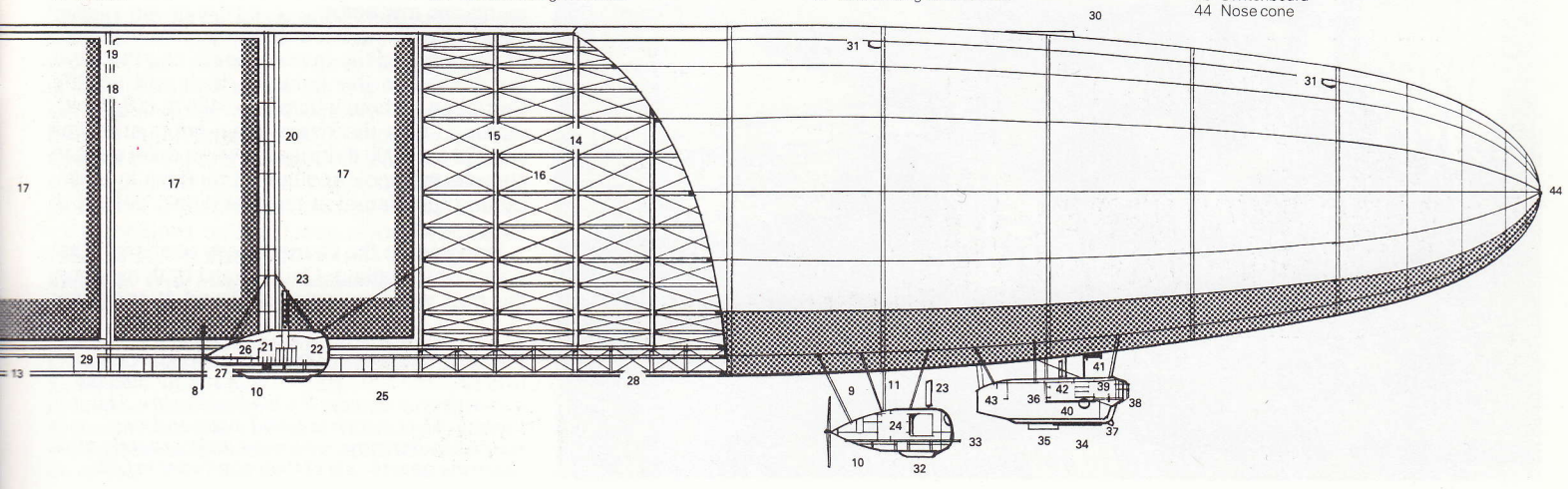
Type: bombing airship
Powerplant: four 179-kW (240-hp) Maybach HSLu six-cylinder water-cooled piston engines
Performance: maximum speed 95 km/h (59 mph); service ceiling 5400 m (17,717 ft); range 3700 km (2,299 miles)
Weight: useful lift 21500 kg (47,399 lb)
Dimensions: diameter 20.09 m (65 ft 10.9 in); length 173.98 m (570 ft 9.6 in); volume 31900 m^3 (1,126,540 cu ft)
Armament: two 7.92-mm (0.312-in) Parabellum machine-guns on free mountings in single gun position above forward hull, plus bombs

Above: Souvenir pictures of SL11's wreckage and the victor were eagerly sought. That Schütte-Lanz construction used wood instead of the more usual aluminium of the Zeppelins gave rise to the belief in some quarters that there was a shortage of metal in Germany. The structure was wire-braced.

Right: It was reportedly possible to read by the light from the doomed SL11. Here it is seen well alight over north London as it appeared at 2.15 am to a photographer outside the police station at Walthamstow. The wreckage at Cuffley was finally doused by the crew of a horse-drawn fire engine.

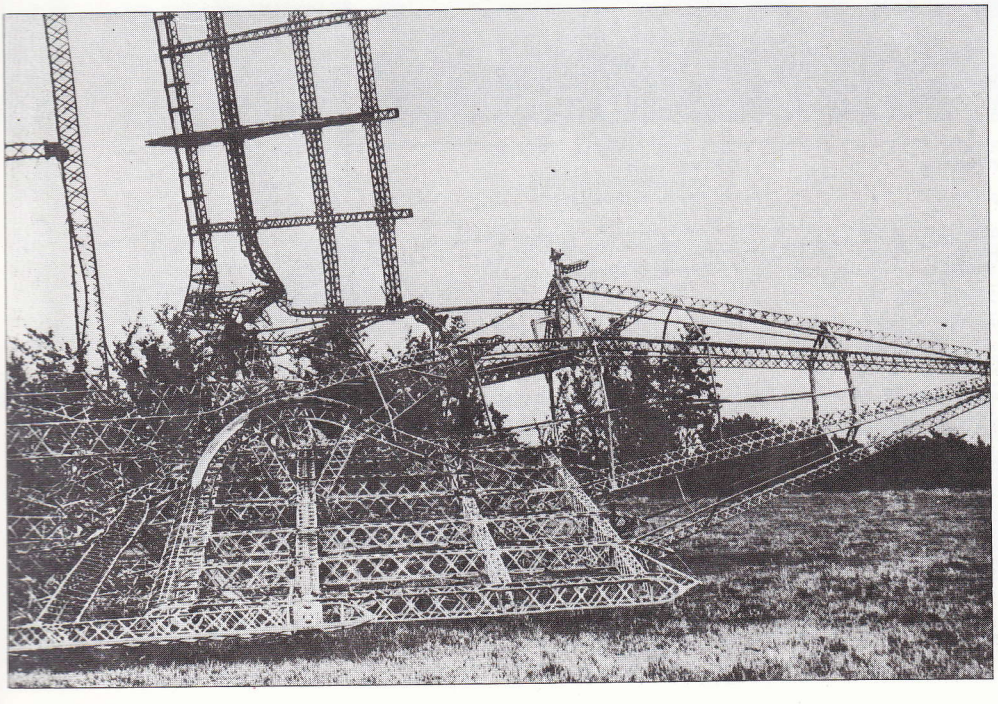
German airship SL11 cutaway drawing key

1 Rudder
2 Upper tailfin
3 Fin structure
4 Elevator
5 Lower tailfin
6 Tailplane
7 Outer covering
8 Propeller
9 Engine car supports
10 Engine nacelle
11 Ladder
12 Keel
13 Gangway/catwalk
14 Main ring
15 Intermediate ring
16 Bracing wires
17 Gasbags
18 Ladder
19 Space between bags allowing escaping gas to exit to vents
20 Protective cage to ladder
21 Maybach HSLu engine
22 Control telegraph
23 Radiator
24 Retractable oil radiator
25 Bomb doors
26 Reversing gear
27 Transmission shaft
28 Water ballast tanks
29 Bomb racks
30 Upper observation station
31 Gas venting valve outlets
32 Shock absorber
33 Handrail
34 Control car
35 Wireless aerial
36 Chart table/wireless
37 Nose light
38 Navigator's/bomb aimer's window
39 Helm
40 Elevator wheel
41 Winch cables
42 Telegraphs
43 Switchboard
44 Nose cone



Death of a Zeppelin

Zeppelins were originally designed for long-range naval reconnaissance, and many spent the bulk of their careers scouting for the High Seas Fleet. August 1918 found the mighty L53 high above units of the Royal Navy's flotilla at Harwich, but far below a Sopwith Camel was launched into the air from a lighter towed by HMS Redoubt. *An historic interception had begun.*



British experiments to perfect a towed aeroplane-launching platform for use at sea had gone on for several months; they at last evolved into a lighter 17.1 m (56 ft) long with a deck 4 m (13 ft) broad, widening to almost 6.5 m (21 ft) forward, which was towed by a destroyer. Several types of aircraft had been involved in the trials, as had some famous pilots, and the combination of Stuart Culley with a Sopwith 2F1 Camel was to make history on 11 August 1918, when the last Zeppelin to be downed in World War I was destroyed.

The airship's number was L53 and it was under the command of ex fire-chief Kapitänleutnant Eduard Proelss when the airship was identified at 08.30 while shadowing the Harwich Force. This included the 'R' class destroyer HMS *Redoubt* towing the lighter No. H5 with, on its deck, a Camel that had taken part in the earlier experiments (N6812), its pilot being again Lieutenant Culley, a former government munitions inspector.

Exactly 28 minutes after the first sighting, Culley slipped the quick-release clip that held the aircraft to the lighter's deck and set the Camel on its hour's climb to 5485 m (18,000 ft), where Culley discovered that his quarry was still 305 m (1,000 ft) higher; it was a difference in altitude that took another 28 minutes to close, putting the Camel at its operational ceiling in the process.

Bringing up the Camel's nose so sharply that it was near stalling, Culley fired both his guns; the port weapon jammed almost at once, but

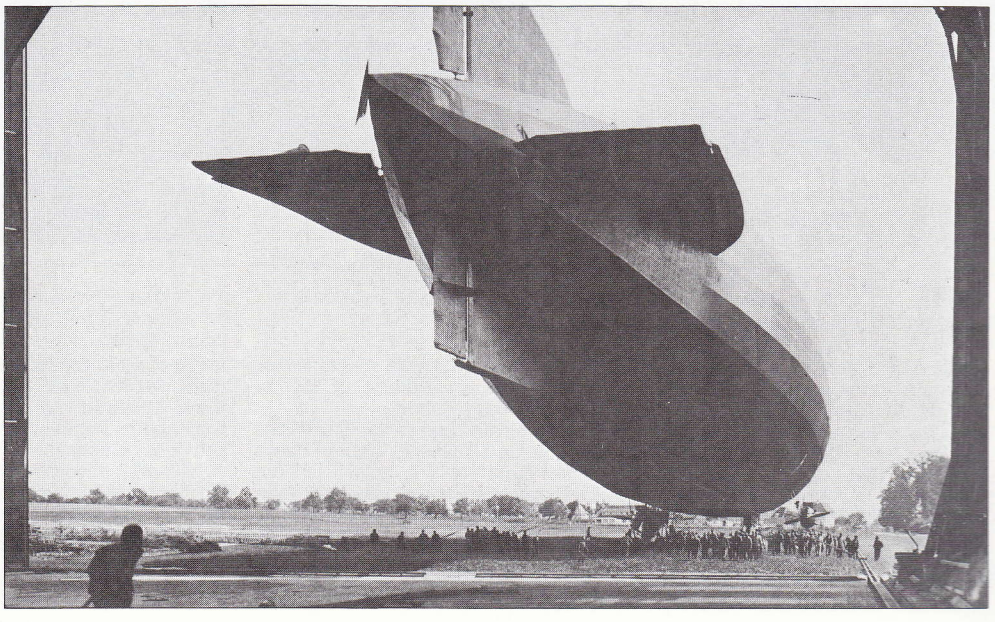
The great skeletons of Zeppelins brought down over England were studied with awe by civilians and with great interest by the Air Ministry. This is the hull of L33, which crashed intact and was burned by her crew, who were lucky indeed not to share the ghastly fate of their comrades in L53.

A stippled demarcation divided the upper surfaces from the black finish on the lower two-thirds of L53's hull, designed to disguise its presence. It failed to do so from Stuart Culley who, with his aircraft dangerously near the stall, pumped incendiary bullets into the hull until it exploded. Bombs and gondolas fell away until finally the blazing nose became detached and plunged into the sea, 5 km (3 miles) below. The doomed crewmen were the last to die in World War I.

fire from the other could be seen striking the Zeppelin's hull as Culley broke off the action when his aircraft fell away in a stall. At this moment something made him look back, just in time to see flames leaping along the monster's side. A moment later came a gigantic explosion that set L53 ablaze from stem to stern as it sank nose first.

So great was the blaze that all fabric had gone when the gaunt framework finally struck the water some 4.8 km (3 miles) below, where it immediately vanished leaving only a patch of oil and a smoke trail to indicate that it had ever existed. There were no survivors.

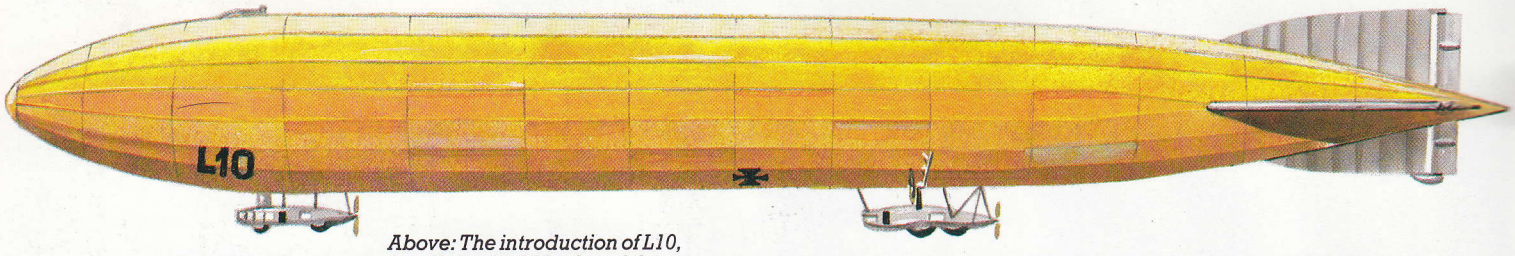
Meanwhile, Culley made for the rendezvous point off the Dutch coast. He had difficulty in finding the naval force and, then running on reserve fuel, prepared to ditch near a fishing vessel. When just about to do so he caught sight of the destroyers, and at once gave vent to his pent-up feelings with a display of aerobatics before alighting in the water close to the *Redoubt*'s bows. From here both pilot and plane were plucked from the water, and the small amount of damage sustained by the latter was soon repaired before it was placed on public exhibition. N6812 may be seen to this day in the Imperial War Museum, Lambeth.



L53 left her hangar for her first raid against England on the evening of 24 September 1917 under the experienced command of Kapitänleutnant der Reserve Eduard Proelss. Although famous as a bomber, 19 of her 23 sorties were the scouting missions for which she was designed.

GERMANY

L10 (Zeppelin LZ40)



Above: The introduction of L10, together with L11, placed the German navy on an equal footing to that of the army with regard to its ability to mount raids against targets in the British Isles.

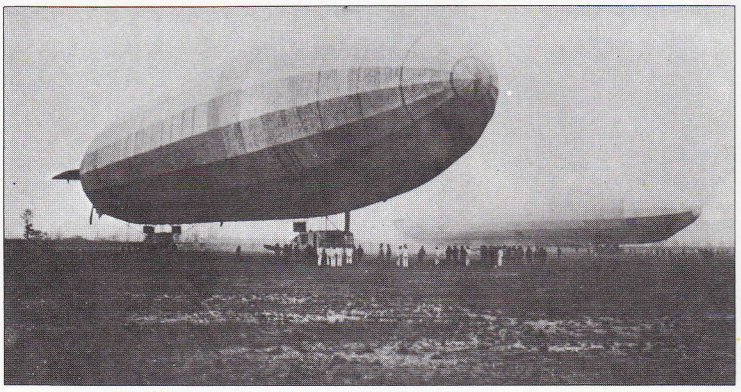
January 1915 was the date set for the introduction of a new type of German bomber airship, the **Zeppelin Typ P**. In point of fact the first of the new vessels was four months late in making its appearance, the lead ship **L10** (builder's designation **LZ40**) being delivered in mid-May. The ship was sent on its attack against targets in England in the following month with a raid on London, it being believed at all levels and on both sides of the North Sea that the selection of individual targets was possible. In point of fact, the weather took a hand, and L10 was able to get only as far as Gravesend, where its bombs chanced to set light to a military hospital with a consequent reaction against such 'frightfulness'.

Another attack was mounted 11 days later when Jarrow and South Shields were the targets, despite heavy fire from the defence batteries on the coast. Three other occasions found the new Zeppelin over the British Isles from a total of 28 military excursions from Nordholz. The German system of organization meant that the flights were usually carried out by the same crews, so that some became more experienced than others, but mindful of the dangers the men tended to live only for the day and to endure bombing trips under thousands of cubic metres of explosive gas and in numbing cold as best they could.

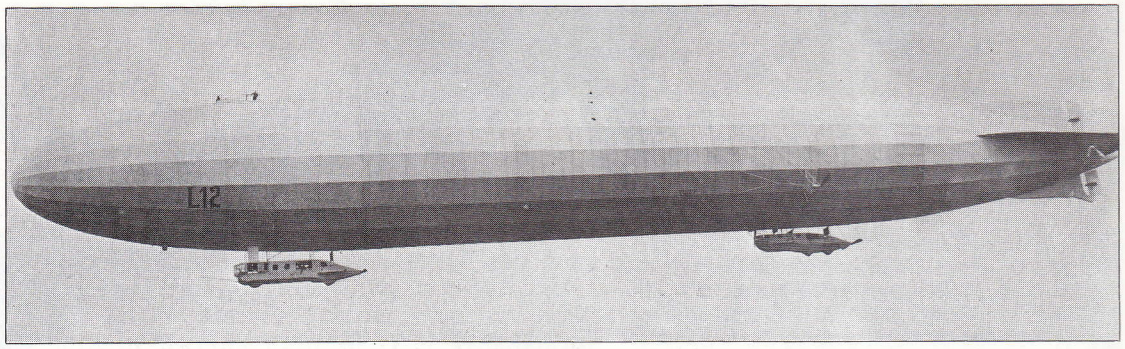
Strangely, it was on what should have been an uneventful flight, a maritime reconnaisance on the afternoon of 3 September 1915, exactly a year before SL11 was destroyed, that the L10's career ended. While the airship was making ready to land back at Nordholz near Cuxhaven, the order to valve off gas was given as a normal preliminary to making landfall. Unfortunately a thunderstorm happened to be raging and the naval airship was struck by lightning. There was a violent explosion before the vessel plunged into the shallow waters below, where it burned for several hours. All aboard perished, Kapitänleutnant Hirsch the commander and his crew of 18. Total production of the Typ P was 10 units, **L10** to **L19** (builder's designations **LZ40, LZ41, LZ43, LZ45, LZ46, LZ48, LZ50, LZ53, LZ52** and **LZ54** respectively).

Specification

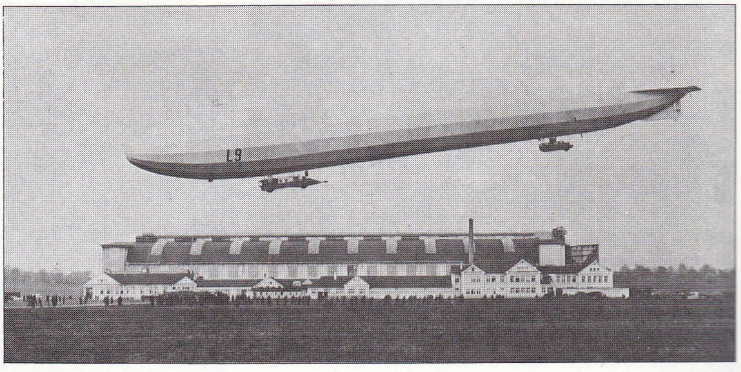
L10 (Zeppelin LZ40)
Type: strategic bomber airship
Powerplant: four 156.6-kW (210-hp) Maybach CX six-cylinder water-cooled piston engines
Performance: maximum speed 95 km/h (59 mph); service ceiling 3900 m (12,795 ft); range 2150 km (1,336 miles)
Weights: empty 21100 kg (46,518 lb); useful lift 26200 kg (57,760 lb)
Dimensions: diameter 18.70 m (61 ft 4.2 in); length 163.50 m (536 ft 5 in); volume 31900 m^3 (1,126,540 cu ft)
Armament: two 7.92-mm (0.312-in) Maxim machine-guns on free mountings in single gun position above forward hull, plus bombs



L11 (in the foreground) was one of the Zeppelin fleet participating in the first permitted raid on London that suffered no restrictions on 10 August 1915, and again on 17 August. Behind is L6, once used to take Strasser as an observer, but it was forced back by engine trouble.



Above: Peterson's L12 passed over Margate, Ramsgate and Deal on 9 August 1915 before bombing Dover in mistake for the naval base of Harwich. All but three of the 92 bombs dropped landed in the sea, and the Zeppelin was damaged by the 76-mm (3-in) naval guns of the defences.



Right: On the night of 9 August 1915 L9, under the command of Odo Loewe, had to take evasive action over Flamborough Head despite a severed rudder cable, before managing to bomb Goole.

GERMANY

L53 (Zeppelin LZ100)

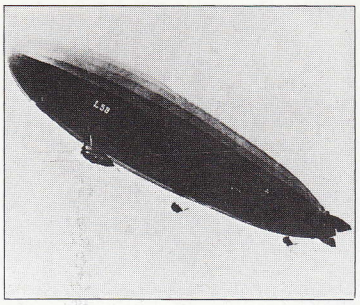
Apart from the historical factors surrounding the last operation carried out by **L53**, this **Zeppelin Type V** airship was also of some technical prominence. This lay in the fact that her construction embodied an increased spacing of her main frames, which were now 15 m (49 ft 2.5 in) apart compared with the previous norm of 10 m (32 ft 9.7 in). Measures such as these served to lighten the L53, contributing to the fact that her useful lift was some 62.7 per cent of the total, so that on her maiden raid an altitude of 6300 m (20,670 ft) was attained.

Alternatively known by the works designation **LZ100**, this airship made its first flight on 18 August 1917 from Friedrichshafen where she had been built, and became the command of one of Peter Strasser's most senior officers, Kapitänleutnant der Reserve Eduard Proelss. He first brought his new charge over the British Isles on the night of 24/25 September 1917 when raids were directed against targets in the Midlands and north east, 17 months after his first bombing sortie in L13, his previous command.

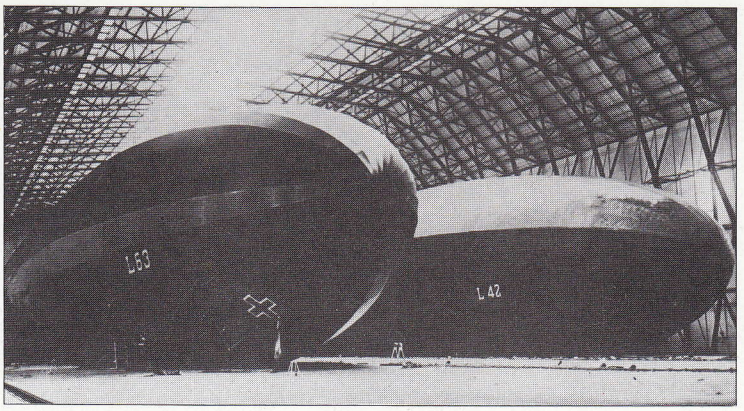
However, it would be wrong to give the impression that Zeppelins were entirely directed to bombing missions against land targets. L53 is an illustration of this fact since of the 23 operational sorties made by this vessel between her commissioning date on 21 August 1917 and her fiery end on 11 August of the following year, only four were bombing attacks. The remainder were scouting missions over the North Sea where the endurance of lighter-than-air craft made them superior to any conventional aeroplane of the day. Small wonder therefore that L53 and her nine sister craft (**L55/LZ101, L56/LZ103, L58/LZ105, L60/LZ108, L61/LZ106, L62/LZ107, L63/LZ110, L64/LZ109** and **L65/LZ111**) were regarded

as a standard scout type. All after L56 were fitted with Maybach motors of the supercharged Mb IVa type.

Specification
L53 (Zeppelin LZ100)
Type: strategic bomber and patrol airship
Powerplant: five 179-kW (240-hp) Maybach HSLu six-cylinder water-cooled piston engines
Performance: maximum speed 106 km/h (66 mph); service ceiling 6400 m (20,997 ft); range 4680 km (2908 miles)
Weights: empty 24500 kg (54,013 lb); useful lift 40460 kg (89,199 lb)
Dimensions: diameter 23.90 m (78 ft 4.9 in); length 196.495 m (644 ft 8 in); volume 55990 m^3 (1,977,271 cu ft)
Armament: two 7.92-mm (0.312-in) Maxim machine-guns on free mountings in single position above forward hull, plus bombs



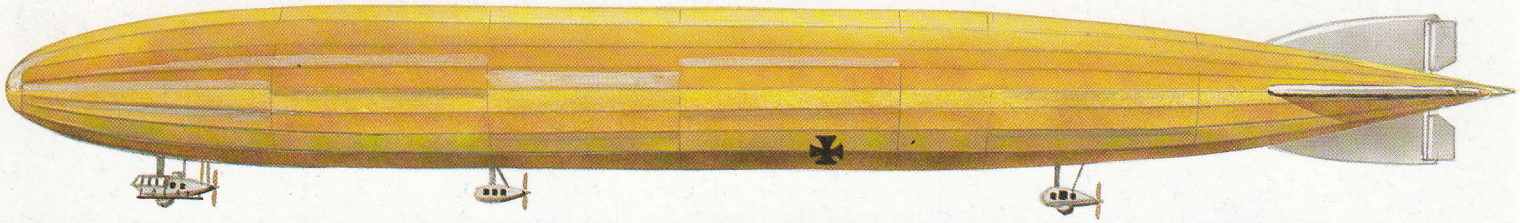
First of the V-type Zeppelins to have new supercharged motors and fourth of the class to be built, L58 was eventually to be destroyed in a mysterious explosion which wrecked four hangars and four other airships at Ahlhorn.



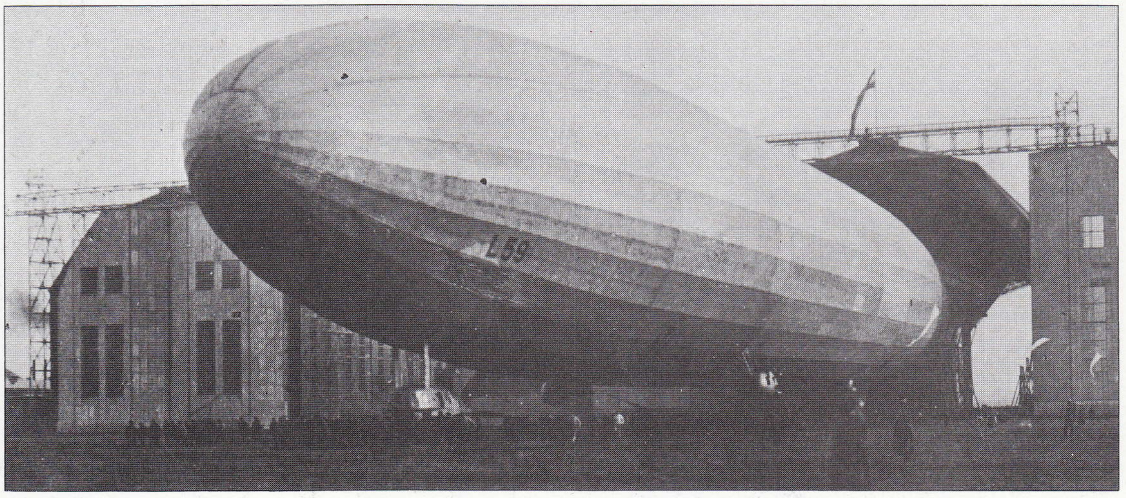
Two victims of sabotage, L42 and L63 lie in their shed at Nordholz after the timber supports and suspension gear had been removed by those loyal to the old regime on 23 June 1919. L42 had been in use as an advanced training vessel, while L63 had been Gerhold Ratz' command.

GERMANY

L59 (Zeppelin LZ104)



First introduced by the Zeppelin company in August 1917, L59 and its class represented the latest design techniques and established a pattern that was to persist for almost a year, 10 being envisaged by the parent company when the first appeared.



When L57, a Zeppelin of the W-type, was severely damaged in a storm in October 1917, L59 was placed in the charge of the same commander as a replacement. After being rebuilt following the African flight, she bombed British naval installations on Crete. A month later U-boat U-53 *was the sole witness of her end.*

While being built as a Zeppelin Typ V, the **L59 (LZ104)** was hurriedly lengthened as the second **Zeppelin Typ W**. This was to replace the **L57** which had been chosen for a special mission in November 1917 and, as the **LZ102**, converted from a Typ V to the first Typ W before being damaged in a storm in October. L57 was intended to fly to German East Africa to aid General von Lettow-Vorbeck's forces in the theatre by flying out a sizeable quantity of supplies; the vessel was thereafter to be used as a bomber.

Together with the best men of his crew (the cream of each usually moved with the commander) Kapitänleutnant Ludwig Bockholt from L57 took charge of L59 without delay, and such was the urgency of the mission that when a member of the crew was discovered to have sold a large part of the rations and made up the cases with the equivalent weight, there was no time to re-provision and the deficit had to be made up with emergency self-heating foods.

Although crews for bombing missions were sometimes reduced to 15 to allow an enlarged offensive load, the full complement of 21 was carried when the vessel set out in November. However, the airship was forced to turn back twice, on the second occasion as a result of damage caused by rifle fire from Turkish railway guards, so that a 32-hour return journey resulted in the next attempt being delayed until suitable weather on 20 November.

In point of fact a large portion of von Lettow-Vorbeck's forces had been forced to surrender on the same day, the commander escaping with a small party to continue the fight after capturing Portuguese supplies, but the recall by radio failed to be picked up in L59. Instead course was set across the Libyan desert where the heat made the vessel difficult to control after gas had been lost through the automatic valves; soon after this one engine began to give trouble.

The vessel was beyond the Nile when one of the recall signals was finally heard and the long return trip began. The tropically-kitted crewmen were by now not only exhausted but suffering from the cold at the height where the flight was taking place, but the final leg of the journey was successfully completed and rightly hailed as a triumph by the German Naval Airship Service, which was still regarded as experimental with the officers and men undergoing 'on the job' training.

The problem remained what to do with the vessel and after a lengthy discussion it was decided to rebuild her for attacks against targets in the Middle East and Italy, and for these she was back at Jamboli (from which the African trips had begun) in February 1918. It was flying from here on 7 April 1918 that L59 mysteriously blew up not far from the heel of Italy.

Specification
L59 (Zeppelin LZ104)
Type: strategic bomber and patrol airship
Powerplant: five 179-kW (240-hp) Maybach HSLu six-cylinder water-cooled piston engines
Performance: maximum speed 108 km/h (67 mph); service ceiling 8200 m (26,903 ft); range 8000 km (4,971 miles)
Weights: empty 27625 kg (60,903 lb); useful lift 52100 kg (114,861 lb)
Dimensions: diameter 23.95 m (78 ft 6.9 in); length 226.50 m (743 ft 1.3 in); volume 68500 m^3 (2,419,059 cu ft)
Armament: provision for up to 10 7.92-mm (0.312-in) Maxim machine-guns above hull, plus bombs

Zeppelins over England: Strasser's Last Mission

The career of Peter Strasser parallels the story of the German airship service. Promoted Leader of Airships in 1913, he led the first strategic bombing campaign in history. The defences eventually mastered the Zeppelin threat, but as Germany's defeat loomed near in August 1918 Strasser personally led another raid. His chosen vessel: L70, the latest and most powerful Zeppelin built.

Peter Strasser, Leader of Airships, poses for a formal portrait wearing the Pour le Mérite *at his throat, an award received from Admiral Scheer at Ahlhorn on 4 September 1917 after commanding airships since 1913. This photograph may have been taken to mark the occasion.*

At the outbreak of World War I it was confidently believed in official circles that the 'terror weapons' of the day, German Zeppelin airships, could not fly during the hours of darkness, and any that crossed the North Sea in daylight would be destroyed with little difficulty by aeroplanes of the Royal Flying Corps.

The fact that airships had been flying sorties after dark for several years made nonsense of the first belief, but there is a ring of truth in the fact that the last Zeppelin to be destroyed by the defences was shot down in daylight at the end of a glorious August afternoon, the finest Bank Holiday in England for seven years it was claimed, the doomed airship taking to his death the revered Fregattenkapitän Peter Strasser, Leader of Airships since 1913.

The formal portraits of this officer, with his heavy moustache and goatee beard of almost theatrical cut above an archaic uniform wing collar, have left to us little impression of what he was really like. But if among a leader's chief qualities is a readiness to share the dangers of his men, then it is easy to see why Strasser quickly gained their respect, and it is certainly true that he was the driving force behind the airship section of the German navy.

Strasser was born on 1 April 1876 at Hanover and at the age of 35, after a career in the Kaiser's navy, he volunteered for aviation duty, a move that in 1913 relieved him from serving as a gunnery specialist in the Naval Airship Division's shipboard ordnance department. Strangely, it was the accident to the naval airship L1 that gave Peter Strasser his first real chance for when this airship, otherwise known by its maker's designation LZ14, crashed into the sea off Heligoland in September 1913, among those who perished was Korvettenkapitän Friedrich Metzing, whose loss left a vacancy filled by Strasser. The leader's role now embraced not only the normal duties of his command, but also participation in design improvements on which first-hand knowledge gained while flying with his men enabled him to comment. There is no doubt that even when the final days of the war cast the shadow of inevitable defeat over Germany, Strasser showed little loss of enthusiasm for the airship in which he still fervently believed. Thus 5 August 1918 found him aboard the very latest type of Zeppelin, prototype of the X-type, heading for the UK.

This vessel was L70 (LZ112) under the command of the inexperienced and impulsive Kapitänleutnant Johann von Lossnitzer, and was then part of the first airship raid to be mounted for four months. It was in company with L53 (LZ100), L56 (LZ102), L63 (LZ110) and L65 (LZ111), flying in a rough 'vic' formation over the North Sea at 5000 m (16,404 ft), at 18.30 only some 100 km (62 miles) from the English coast and thrown into sharp silhouette by the light of the late afternoon.

This is how the crew of the Leman Tail Lightship saw them when 48 km (30 miles) from the coast of Norfolk, and is also how one of the Zeppelins appeared to Major Edgar Cadbury, 25-year-old heir to a confectionery empire, as he raced along the sea front at Great Yarmouth.

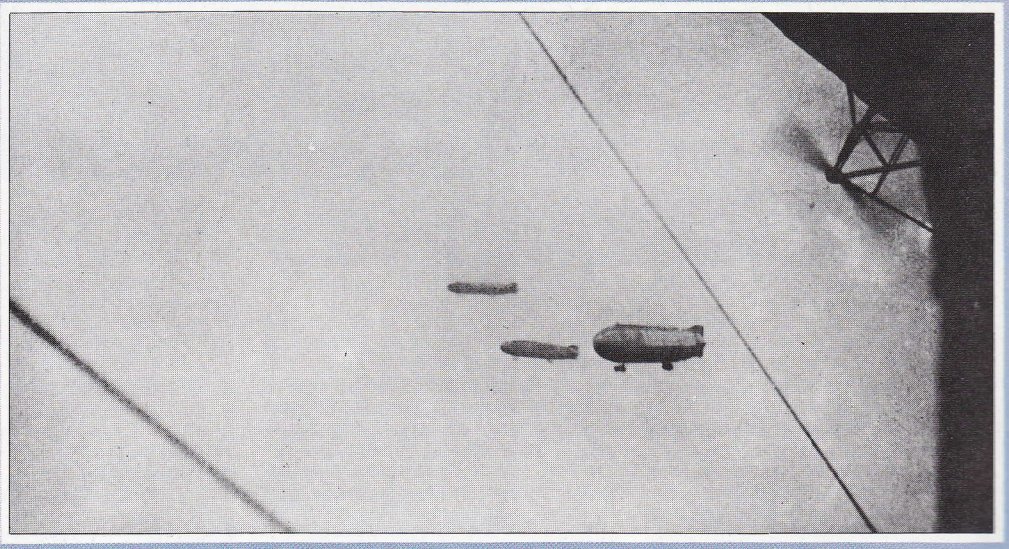
He had been called from watching his wife who was singing at a charity concert at the Naval Air Station, but his mind was filled now with only two thoughts: surprise at the German appearance in daylight, and how quickly he could reach his car and report to the aerodrome where a two-seat de Havilland D.H.4 stood ready to do duty as an interceptor.

Bringing his Ford to a screaming halt, Cadbury almost fell out of the car, and attempting to put on the helmet and jacket he had seized in his rush he sprinted for the biplane in company with another running figure made awkward by flying kit, namely Captain Robert Leckie, who was to act as gunner in the rear cockpit.

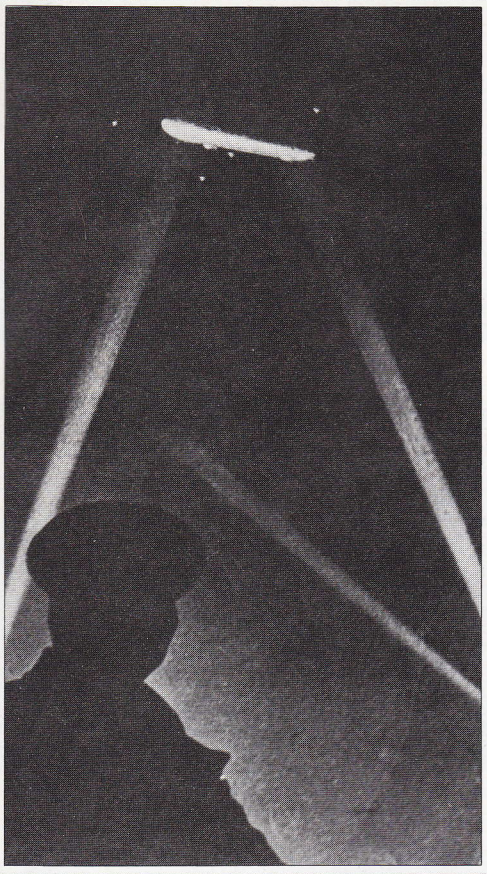
Meanwhile, the German airship formation continued on course, heading for targets specified in their orders as being 'on the south or middle' after a journey that up to then had lasted for about 4½ hours. The commanders were mindful that no bombs were to be dropped on London without orders from Peter Strasser, who was in the leading vessel with its long hull almost entirely covered in an incongruous coat of black, unsuitable for concealment in daylight. Strasser seemingly subscribed to the theory that there was no need to fear being shot down over the sea if one was at an altitude between 4500 and 5500 m (14,765 and 18,045 ft).

The camouflage finish of the airships in fact served some purpose when the interceptors caught up with them, for it was now 22.20 and the summer light was fading. Even so Cadbury and Leckie had no difficulty in picking out the whole formation, and having done so the pilot flew in the opposite direction to gain extra height, reducing the D.H.4's load by pulling the release to dump into the sea the pair of bombs it was carrying.

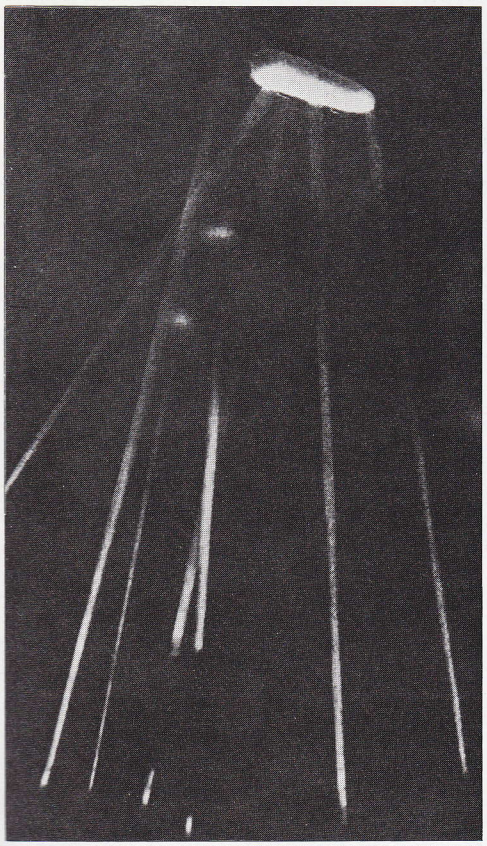
Approaching the monster from almost head-on, Leckie, after some ranging shots that went wide since his Lewis gun had no sights, put in a lengthy burst of fire at 550-m (600-yard) range: the burst exhausted a whole drum of Pomeroy explosive ammunition and succeeded in blowing a large hole in the Zeppelin's fabric, starting a fire that swiftly ran the length of the hull. In a moment the airship lifted its nose before turn-



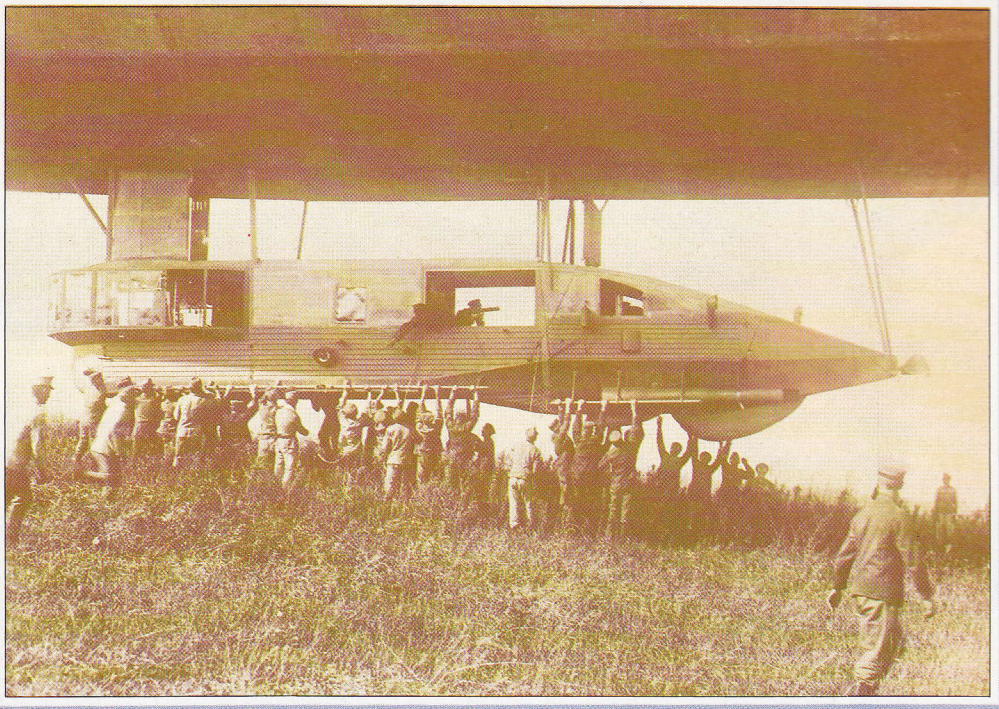
Zeppelins L10 (Wenke); L11 (von Buttlar); L12 (Peterson); and L13 (Mathy) cross the North Sea on 9 August 1915. L10 dropped 12 HE bombs on Sheppey, but Mathy had to withdraw. L12 was hit by Dover AA fire and force-landed in the Channel; half was later recovered.



A Zeppelin caught by searchlights. This may be the raider which appeared over the eastern counties on the night of 8 September 1915. If so, it is L13 which penetrated as far as London, dropping 15 high-explosive and 55 incendiary bombs before returning via Norfolk.



Once caught by searchlights it was difficult for a Zeppelin to conceal its massive bulk from the guns and aircraft seeking to destroy it. Their only real defence was to shed ballast and climb to altitudes out of harm's way.



This is the gondola of L54, which was to take part in the famous raid by 13 Zeppelins on 19 October 1917, only to be scattered by high winds. Von Buttlar's L54 escaped by abandoning the raid, only to be destroyed in its hangar at Tondern after a strike by Sopwith Camels from HMS Furious.

ing over and plunging into the sea as a mass of flame, a smaller fireball being seen to drop away as a fuel tank became detached to make its own meteor-like course into the waves below.

The wreckage did not sink immediately, but lay on the swell, a great burning pyre for the 21 men who had been its crew and for whom there could be no escape. It rested thus for the best part of an hour and if any of the crew members of the airships that accompanied L70 had been ignorant of their leader's immediate fate, none could have failed to see the holocaust now. Their commanders, horrified at what had taken place, abandoned the operation and turned the bows of their Zeppelins towards home, the water ballast of each pouring out as it was dumped to carry out the only manoeuvre that could still give a margin of safety, the rapid gain of height.

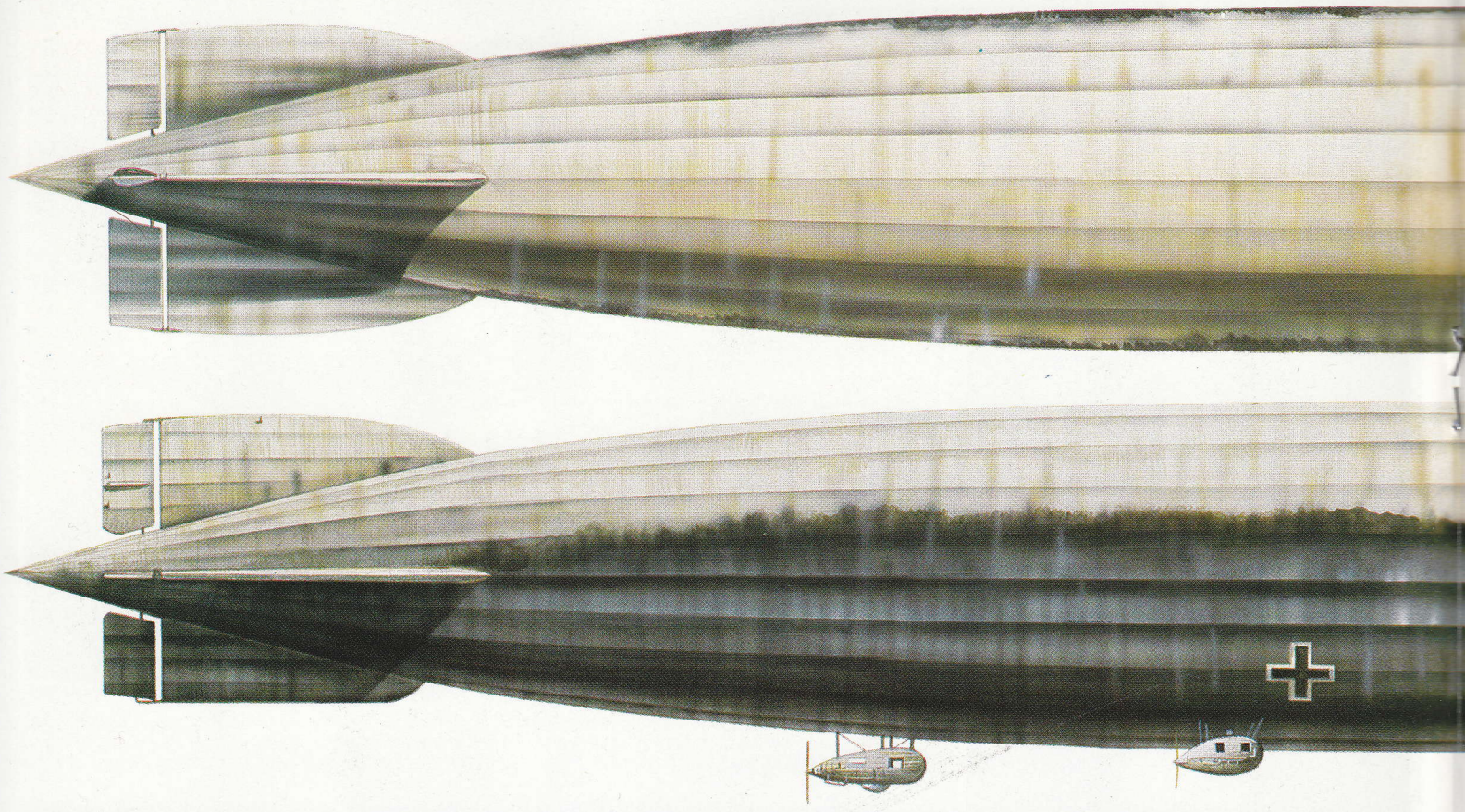
That the raiders were within reasonable distance of each other is shown by the fact that Cadbury and Leckie were able to close on a second airship, L64, despite an engine that was giving trouble, and Leckie opened fire: he believed that he scored hits, and even that a fire had been started, but was wrong. However, the weather began to deteriorate and the two returned to base to find not only that they were welcomed as heroes, but also that the bombs, believed to have gone into the sea to lighten the load, were still in place, so that a very different homecoming might have resulted!

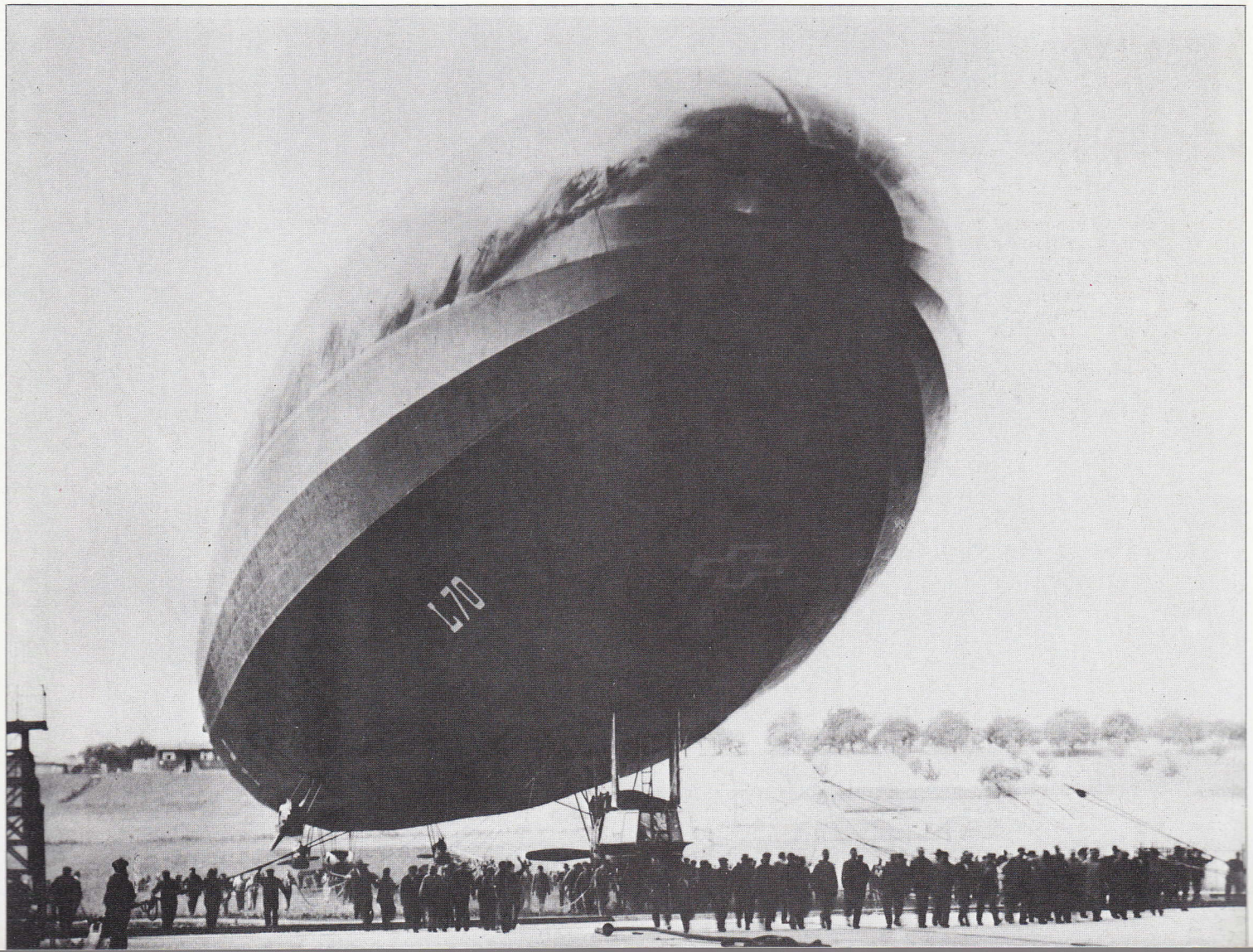
It was 7 August when the remains of L70 were found by the trawler *Scomber*. They were promptly buoyed where they lay in only eight fathoms (14.6 m/48 ft) of water, and later were salvaged over a period of almost three weeks, the greater part being beached at Immingham. In this mass of twisted metal was discovered the bodies of many of the crew, including that of Peter Strasser from whose clothing some documents, including signal codes, were salvaged and rushed to Naval Intelligence; like the corpse from which they were taken, they were undamaged and not mutilated in any way.

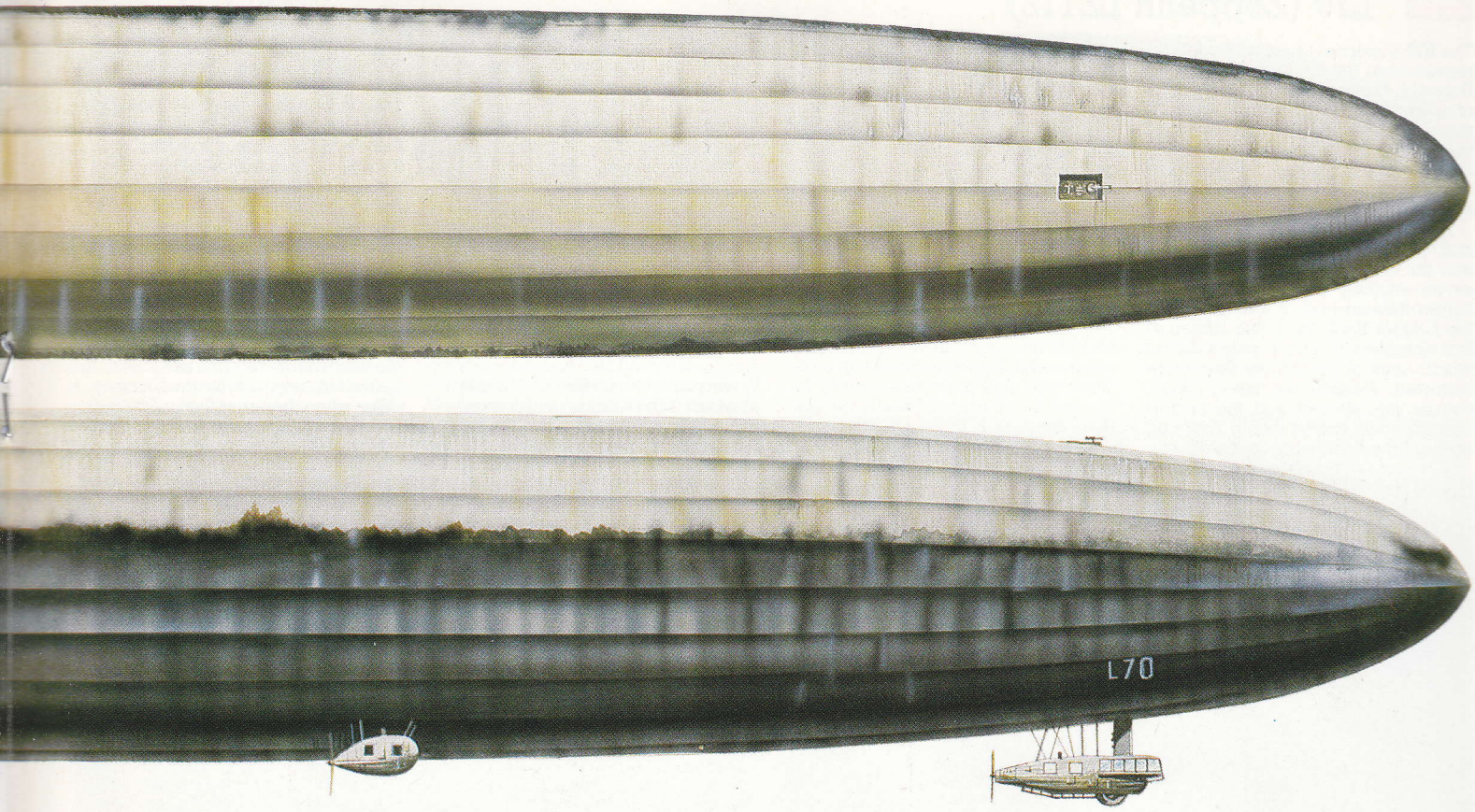
In the days that followed about another half-dozen bodies were washed ashore on the Lincolnshire coast, and these, including the ones recovered from the wreckage and that of Peter Strasser were taken out to sea; there, as befitted naval men, they were committed to the deep, although seemingly with scant ceremony. What remained of L70 was subjected to an examination which revealed such interesting facts as the especially light gauge of some of the metal parts and that silk was substituted for the usual cotton covering; with nothing more to be discovered the wreckage was then dumped into the North Sea.

At home in Germany, the authorities were at first unsure of the fate of Peter Strasser; although realizing the slimness of the chances of escape for the Leader of Airships, several newspapers published tentative obituaries. Few of these failed to mention the respect in which he was held. This was no empty platitude, for Strasser's readiness not only to investigate technical problems, but generally to advance the airship cause, had together with his readiness to share the dangers of operational sorties endeared him to his men, a fact reflected in the manner in which his demise was heard by some. A *Leutnant* entered the room where a group of officers was gathered and stood silent with a look of dumb despair. 'Strasser?' asked one bolder than the others. The *Leutnant* made no reply, merely nodding. Without a word the company removed their caps and stood to silent attention.

Zeppelins over England

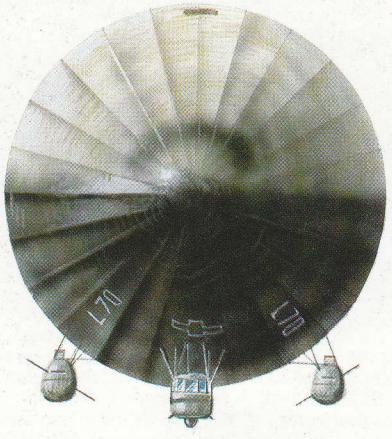


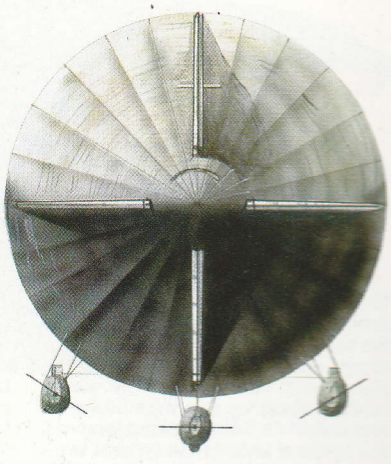




Luftschiffe 70

Above and right: Zeppelin L70, also known by its constructor's designation LZ112, was considered an outstanding vessel and the final version of the 'Super-Zeppelin'. It had been built to a specification which enabled it to climb to an altitude where it might be considered immune from interception. Also, being capable of taking an increased fuel load, it could approach over the coast of Scotland from the circular route across the Atlantic and at the same time provide support for U-boats by remaining in the air for several days.





Left: Newly completed, L70 is walked back into Factory Shed II. Less than a month later she was to crash into the sea off the Norfolk coast, a victim of Cadbury and Leckie in their intercepting Airco D.H.4, despite being powered by motors adapted for high-altitude work.

GERMANY

L70 (Zeppelin LZ112)

The **L70** (company designation **LZ112**) represented the final type of military Zeppelin **(Zeppelin Typ X)**, and was conceived around the importance of making an entry to the Atlantic round the north of Scotland and having swift climb characteristics, the emphasis therefore being put on fuel capacity and a lightened structure.

Four airships of this type were planned, of which L70 was the prototype, and the only one to be powered by seven engines, unique among naval lighter-than-air craft. It was work over the Dogger Bank that found L70 on its first operation, a routine patrol during which units of the British fleet were reported. Despite the heavy cloud, course was altered and the targets identified, 10 bombs being dropped on the ships despite concentrated anti-aircraft fire, an example of the type of action in which lighter-borne interceptors would have been of use.

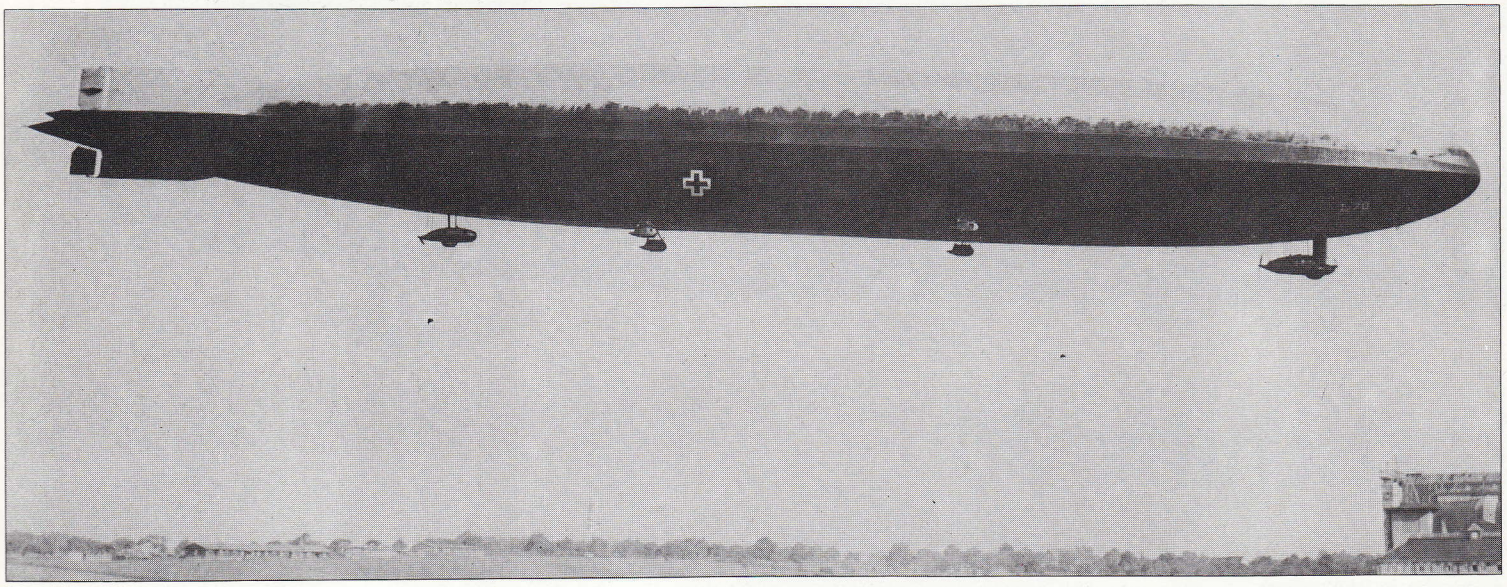
Zeppelins of this type were not planned for patrol work alone, however, and despite the fact that by 1918 aeroplanes were exhibiting much greater usefulness for attacks on targets in the British Isles, the day of the airship was not completely over. Thus the L70 was committed to a raid on 5 August, an attack that some thought foolhardy since it was planned to take place before it had grown completely dark. This is the action which cost the lives of not only the entire crew, including the commander Kapitänleutnant von Lossnitzer who had been responsible for the attack on the naval vessels, but also Peter Strasser.

Of the planned four units of the Typ X variants, only two others were built, though only one was commissioned into the Germany navy. This was the **L71 (LZ113)** later handed over to the UK. The **L72 (LZ114)** was completed after the Armistice as the ***Dixmude*** and was delivered to France as part of war reparations. These vessels differed from the L70 in having six Mb IVa engines and a volume of 68500 m^3 (2,419,059 cu ft) in a hull lengthened to 226.5 m (743 ft 1.3 in).

Specification

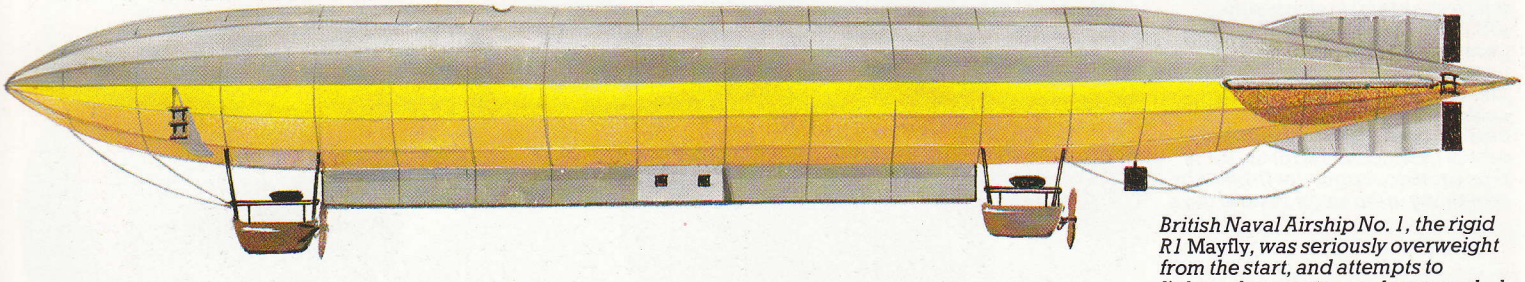
L70 (Zeppelin LZ112)
Type: strategic bomber and patrol airship
Powerplant: seven 193.9-kW (260-hp) Maybach Mb IVa six-cylinder water-cooled piston engines
Performance: maximum speed 130 km/h (81 mph); service ceiling 7000 m (22,966 ft); range 6000 km (3728 miles)
Weights: empty 28260 kg (62,303 lb); useful lift 43500 kg (95,901 lb)
Dimensions: diameter 23.95 m (78 ft 6.9 in); length 211.50 m (693 ft 10.8 in); volume 62200 m^3 (2,196,576 cu ft)
Armament: up to 10 7.92-mm (0.312-in) Maxim machine-guns on free mountings above hull, plus bombs

L70 was the Zeppelin in which Peter Strasser was to die on 5 August 1918. In the interests of weight economy the unshrouded engine exhausts tended to compromise the black dope when they spat flame. She is seen here in July at Friedrichshafen, where she was built.



UK

HMA No. 1 (RI) *Mayfly*



British Naval Airship No. 1, the rigid R1 Mayfly, was seriously overweight from the start, and attempts to lighten the structure only succeeded in weakening it. For security reasons the findings of the investigators were never published.

The UK's first rigid airship was proposed in 1908 as a means of evaluating the naval airship as a weapon of war along German lines, and an order was placed with Vickers. The work was to be undertaken by a joint civilian/naval team, few of whose members had much experience in the type of work involved.

Since the vessel was to be flown from water her gondolas were given planing bottoms, although alternative mooring to a mast anticipated German ideas. Construction was to be of the new alloy duralumin as a compromise between those factions who wanted wood or steel.

Engine tests were begun in mid-February 1911, and it was hoped that the maiden flight might coincide with the Coronation Review of the fleet by King George V. However, the extraction of **HMA No. 1 (RI)** from its floating shed called on the resources of a number of tugs and a hauling party of 300 sailors on the ropes, a difficult task since the airship, now nicknamed ***Mayfly***, proved much heavier than expected. This combined with misdirection of the handling party or (according to some reports) a sudden cross-wind, caused the airship to strike one of the uprights of the shed entrance, some damage resulting. This was unfortunate, since an earlier sojourn in the open had seen the airship successfully moored to the short mast provided as the superstructure of a naval vessel (the first use of such equipment in history) and reports speak of the RI thus riding out a storm with winds rising to as high as 72 km/h (45 mph).

Even so, the damage now sustained had to be repaired, and the airship's return to its shed also provided an opportunity to lighten the structure. It was not until late September that the RI next appeared, fully loaded with hydrogen after a 10-hour inflation of the gas cells and ready for flight. The method of handling was as before, and it was necessary for the airship's nose to be turned. Hardly had the strain been taken on the ropes than a loud crashing was heard from within the centre of the vessel as its back broke. Understandably the crew began to leap overboard as ordered, and with the weight relieved from the rear gondola the stern rose up to complete the destruction. The *Mayfly* never flew and was later scrapped.

Specification

HMA No. 1
Type: experimental naval airship
Powerplant: two 119.3-kW (160-hp) Wolseley eight-cylinder water-cooled piston engines
Performance: (estimated) maximum speed 64 km/h (40 mph)
Weight: (estimated) useful lift 20321 kg (44,800 lb)
Dimensions: diameter 14.63 m (48 ft 0 in); length 156.06 m (512 ft 0 in); volume 18774 m^3 (663,000 cu ft)

UK

'C' class

Designated the **'C' class** from its anticipated use as a coastal type (**'Coastal' class** was an alternative name), this non-rigid type was of medium size and constructed with a trefoil envelope section, frequently known as the Astra Torrès type. The first of the pattern was ordered in June 1915 from Kingsnorth, where it was assembled in the following September.

The choice of envelope construction posed problems that were overcome in an interesting manner. Among these was the method of car suspension: the cables for this purpose were attached along the intersection line of the lobes and from here ran through the bottom of the covering to the car. And it is noteworthy that though the gas cells were contained in a non-rigid structure, it was possible to site one of two defensive gun positions on top.

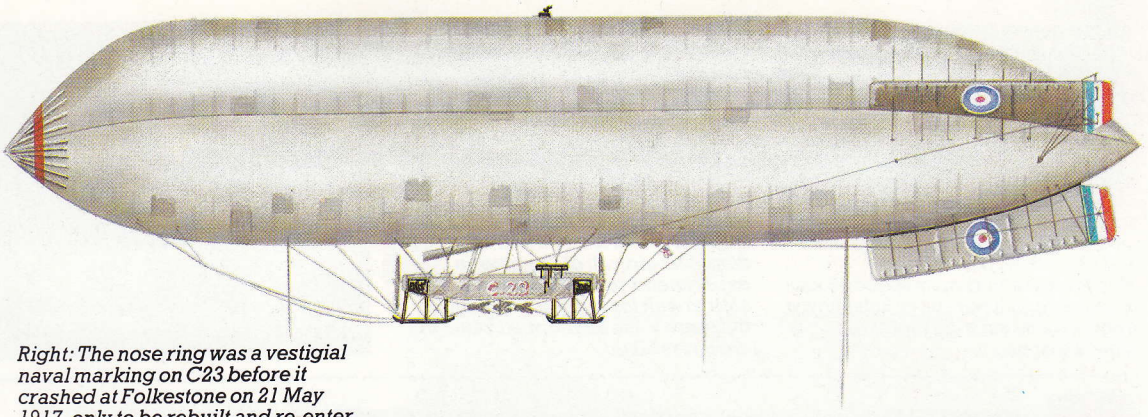
Pembroke was the first naval air station to have the type, and the first flights took place from here in June 1916, other bases being Pulham, Howden, Mullion, East Fortune and Longside. The seas that came under the care of the 'Coastal' class airship patrols were those off the Norfolk coast, Lands End, the mouth of the Humber, the Firth of Forth and Aberdeen.

Although the work of these vessels was largely unspectacular, one was the subject of an interesting set of experiments which were carried out on 6 September 1916. These were made with the first of the type, **C1**, in conjunction with the light cruiser HMS *Canterbury*, and were conducted offshore to look into the question of future developments, whereby an airship might be refuelled from a surface vessel.

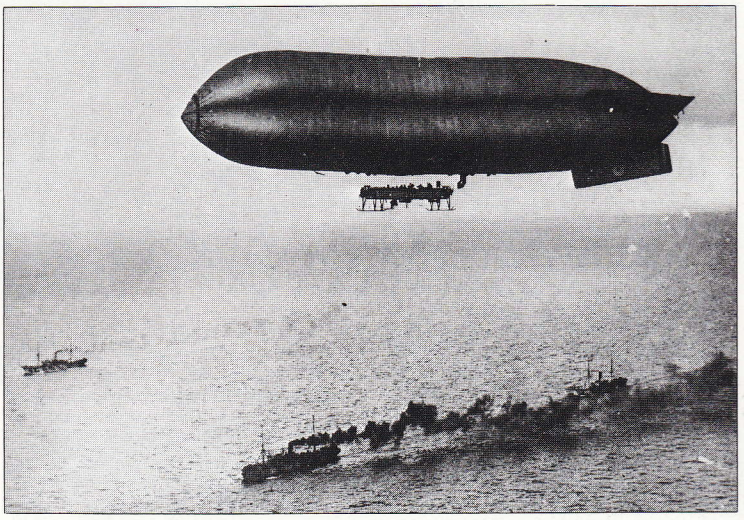
A total of only 26 airships of this class was delivered, although these remained in service for lengthy periods. Thus they enjoyed a reputation for longevity as well as for extended flight times, the endurance of the design being as much as 12 hours.

The crew of these airships consisted of five men, four of them in the car which also contained the two engines, fore and aft, driving tractor and pusher propellers respectively. The men's accommodation was very considerably more comfortable than that of the fifth man, the upper gunner who had a special climbing tube through the envelope to reach his lofty position. 'C' class airships gave good and reliable service once the problems of cooling for the rear engine and blowing in of the nose cone had been solved.

When engines of differing powers were fitted in any one ship, the more powerful was normally that at the rear, while it is interesting to note that the cars were constructed from a pair of Avro 510 fuselages. C1 alone differed from the others in having a 57.9-m (190-ft) envelope with a 3964.4-m^3 (140,000-cu ft) capacity.



Right: The nose ring was a vestigial naval marking on C23 before it crashed at Folkestone on 21 May 1917, only to be rebuilt and re-enter service as C23A. The type had small variations of airscoop position and car details.



A 'Coastal' class airship on convoy patrol shows the later location of the ballonet airscoop in the aft position. This differed from that on the original model, which was set forward immediately behind the front propeller. Only 27 of this class were delivered before 1918.

Specification
'C' class
Type: sea patrol airship
Powerplant: two 111.9-kW (150-hp) Sunbeam six-cylinder water-cooled piston engines, or one 179-kW (240-hp) Fiat and one 82.0-kW (110-hp) Berliet water-cooled piston engines
Performance: maximum speed 80 km/h (50 mph); service ceiling 2134 m (7,000 ft)
Weight: useful lift 1608 kg (3,545 lb)
Dimensions: width 12.04 m (39 ft 6 in); length 59.66 m (195 ft 9 in); volume 4813.9 m^3 (170,000 cu ft)
Armament: two 7.7-mm (0.303-in) Lewis machine-guns, plus bombs

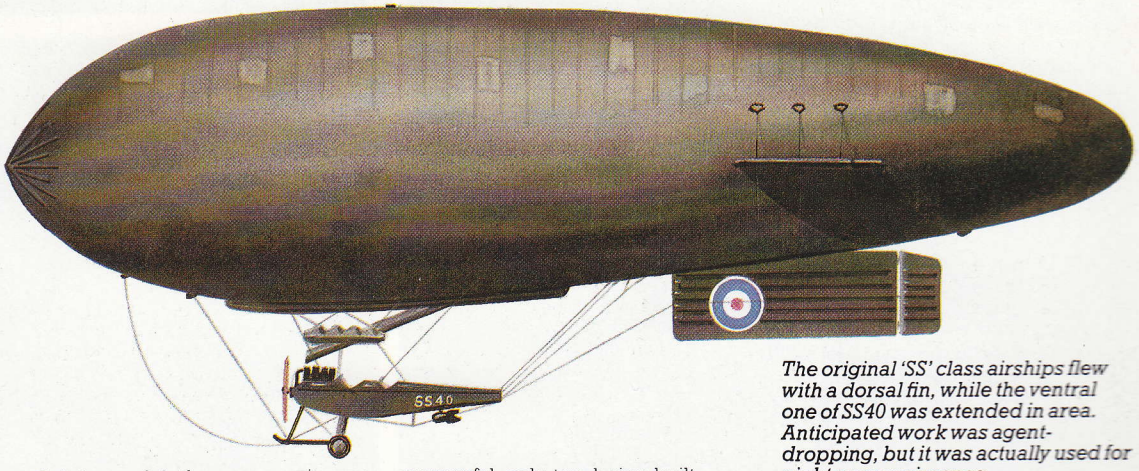
UK

'SS' class

Hurriedly conceived as a composite of the *Willows IV* (HMA No. 4) airship and a car formed from the fuselage of an RAF B.E.2c aircraft, the resultant combination was a simple non-rigid that could be used for submarine hunting and convoy protection. It was first tested in March 1915 and given the designation **'SS' class**, indicating 'Sea Scout' or 'Submarine Scout'.

Alternative cars could be fitted, and although the greater number used the B.E.2c fuselage (these being **SS1** to **SS3**, **SS8** to **SS10A**, **SS12** to **SS20**, and **SS23** to **SS25**), 11 were fitted with Armstrong Whitworth cars and 12 with Maurice Farman cars. Some are on record as going to France and Italy, while they also inspired certain US vessels of similar construction.

The 'SS' class was used for patrols over the Dover Straits and Irish Narrows, the first base to have the type being that established at Capel near Folkestone on 8 May 1915; a second base began operations with the 'SS' on 6 July of the same year, this being at Polegate (Eastbourne) where there were three, compared with five at Capel.



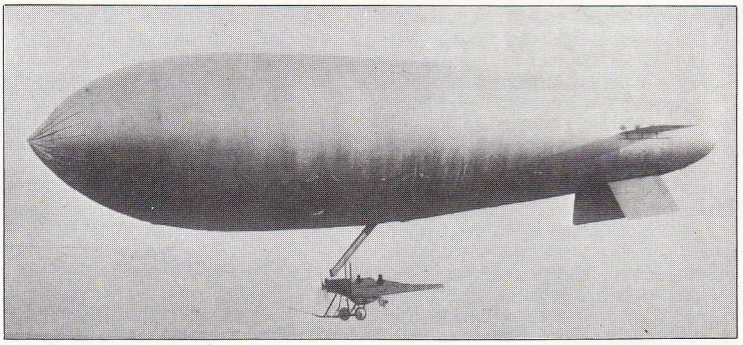
The original 'SS' class airships flew with a dorsal fin, while the ventral one of SS40 was extended in area. Anticipated work was agent-dropping, but it was actually used for night reconnaissance.

In later models the gas capacity was increased first to 1699 m^3 (60,000 cu ft) and later to 1982 m^3 (70,000 cu ft) from the original 580.5 m^3 (20,500 cu ft). Other more radical variations were introduced to produce the 'SST' class, which had twin engines but of which only six were constructed, and the **'SSP' class** (the last letter indicating pusher propulsion) that was even less successful, only two being built.

As might be expected these airships, which gave to the English language the word 'Blimp', had the capability to stay aloft for many hours, the normal flight duration being seven hours although records exist claiming up to twice this figure. The type served throughout the war on the same duties and certainly had a deterrent effect on submarine commanders, whose vessels it was possible to see below the surface of the water. Some, with Armstrong Whitworth F.K.3 fuselages doing duty as their cars, were powered with 74.6-kW (100-hp) Green water-cooled motors as an alternative to the standard powerplant, the Hawk

engine being particularly associated with the Maurice Farman nacelles. Production was about 150 'SS' class airships.

Specification
'SS' class
Powerplant: one 55.9-kW (75-hp) Renault V-8 or Rolls-Royce Hawk six-cylinder water-cooled piston engine, or one 74.6-kW (100-hp) Green water-cooled piston engine
Performance: maximum speed 48 km/h (30 mph) with Renault or Rolls-Royce engine, or 80 km/h (50 mph) with Green engine
Weight: useful lift 3001 kg (6,615 lb)
Dimensions: diameter 9.75 m (32 ft 0 in); length 43.59 m (143 ft 0 in); volume 1982.2 m³ (70,000 cu ft)
Armament: one 7.7-mm (0.303-in) Lewis machine-gun, plus bombs



An unmarked 'SS' class airship is seen with twin ventral fins and a B.E.2c-type car. A similar envelope was fitted with one of a pair of complete aircraft of this type, in experiments to take an aeroplane aloft to wait for raiding Zeppelins. But these were abandoned when the crew was killed.

UK

'SSZ' class

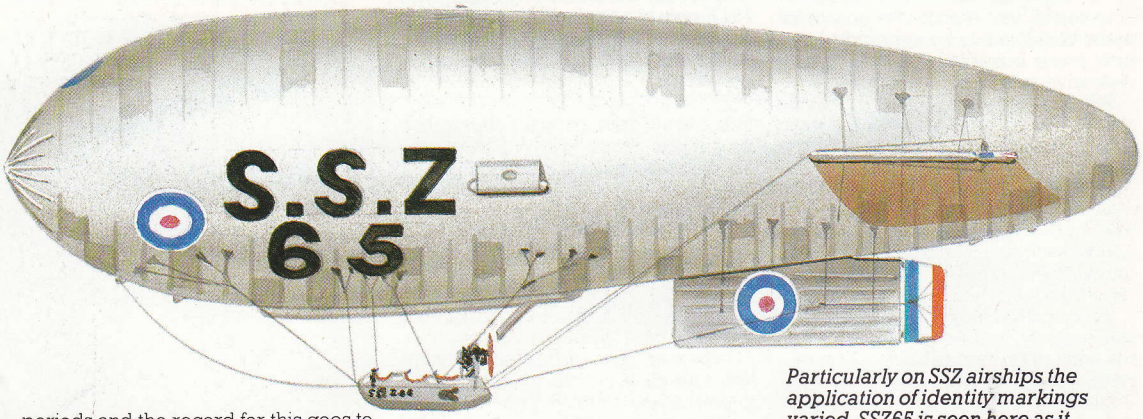
The final variant of the 'SS' class airship was the **'SSZ' class** (Z indicating the ultimate or zero form), of which no less than 93 were ordered although only 63 of these went to the Royal Navy: **SSZ23** and **SSZ24** were sent to the United States where the latter became A5472, while **SSZ21** and **SSZ22** went to France.

The type was introduced late in 1916 and although the engine was usually the Rolls-Royce Hawk, two were fitted with the Renault V-8 of similar rating, and all were used for similar work to that performed by the earlier 'SS' type. The main visual difference between the two classes was the specially designed car that took the place of the aeroplane fuselages used formerly.

In fact the 'SSZ' was not originally intended for sea patrol, being designed to be towed by surface vessels of the Belgian coast patrol and by monitors, when their role would have been no more than aerial platforms for gunnery spotting after release and under their own power.

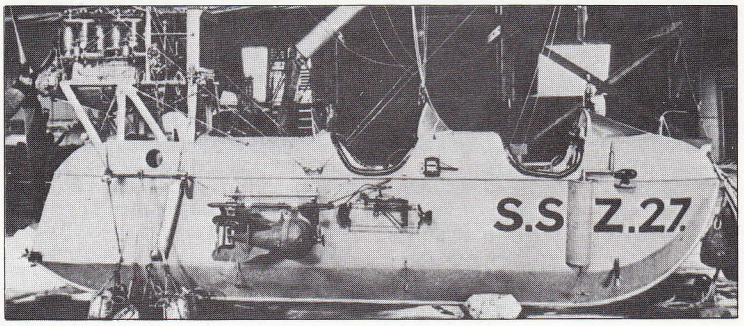
The very first airship of this type was in fact built at Capel (Folkestone) and later flown to the Dunkirk area, where it was based at St Pol on 21 September 1916, three months after it had been contructed.

Perhaps the chief claim to history enjoyed by the 'SSZ' is the fact that, despite being of non-rigid construction and therefore capable of being flown only if the weather was suitable, they were responsible for spotting 49 submarines, of which 27 were claimed as sunk. To do this it was necessary for the airships to remain aloft for lengthy periods and the record for this goes to the crew of **SSZ39**, who remained in the air during the summer of 1918 for a continuous period of 50 hours. This was more than double that of the accepted 'long patrol', which was in the region of 24 hours, although the average was 12.

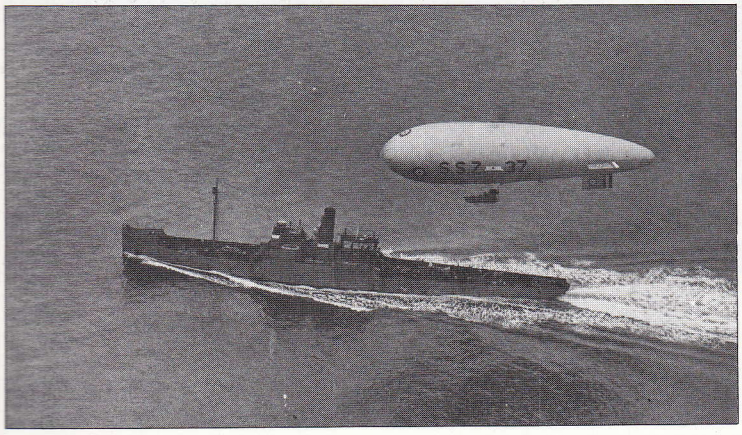


Particularly on SSZ airships the application of identity markings varied. SSZ65 is seen here as it appeared at Longside in 1918, although some operations were carried out from Auldbar.

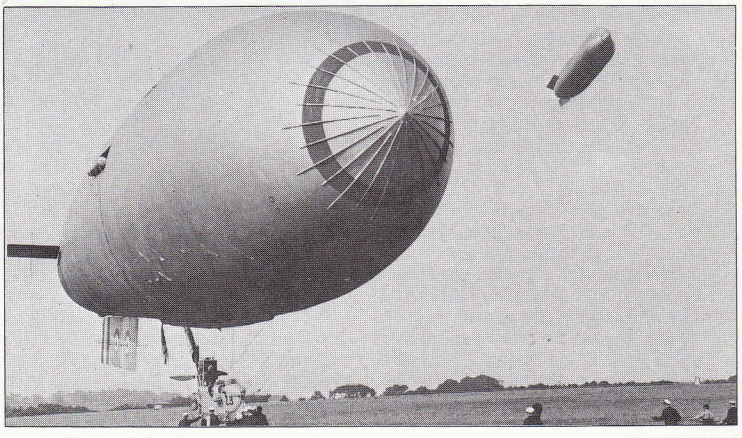
Specification
'SSZ' class
Type: sea patrol airship
Powerplant: one 55.9-kW (75-hp) Rolls-Royce Hawk six-cylinder or Renault V-8 water-cooled piston engine
Performance: maximum speed 77 km/h (48 mph); service ceiling 2400 m (7,875 ft); normal endurance 12 hours
Weight: useful lift 3300 kg (7,275 lb)
Dimensions: diameter 9.75 m (32 ft 0 in); length 43.59 m (143 ft 0 in); volume 1982.2 m³ (70,000 cu ft)
Armament: one 7.7-mm (0.303-in) Lewis gun for the observer, plus bombs



Details of the car of SSZ27, which was based at Polegate before moving to Mullion, show the snug crew accommodation and the method of suspending the bomb load for anti-submarine work. These and other airships were handled behind vast screens to prevent wind damage.

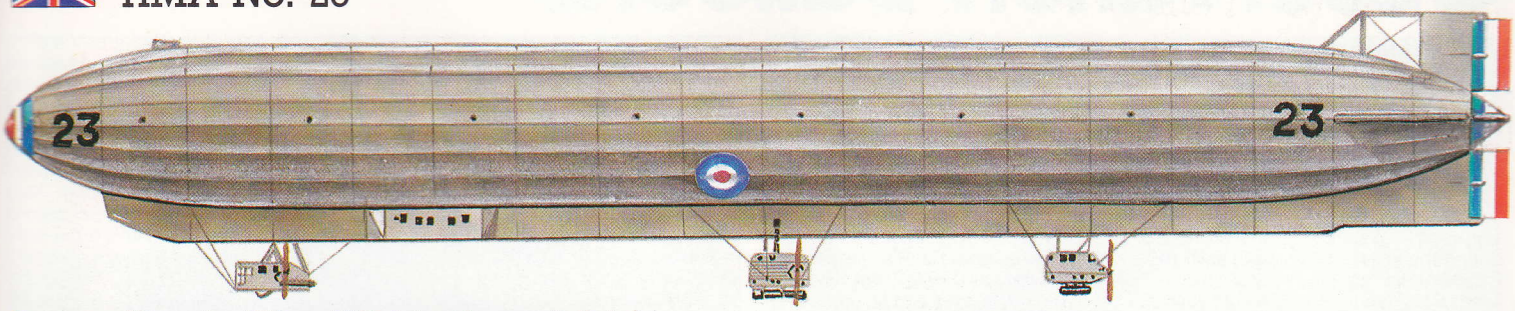


SSZ37 flies from its station at Pembroke above a minelaying sloop. The cylindrical fuel tanks slung at the sides of the envelope were not always in evidence. The type was still in production in 1918, when orders for the final 15 were cancelled at the end of the war.



SSZ3 with its ground party served both at Pulham and East Fortune. Like the 'SS' and 'SSP' vessels, some were fitted with ventral fins of increased area. SSZ3 here lacks the envelope roundel of many, but has a naval nose ring and flies the White Ensign behind the scoop.

HMA No. 23



October and November 1918 saw R23 in its best-known role, that of air-launching Sopwith Camels N6622 and N6814. Although used mostly for training, it had carried out North Sea patrols and later participated in the victory celebrations of 1918.

When **His Majesty's Airship No. 9 (HMA No. 9)** was delivered in the closing months of 1916 it was almost obsolete as a result of the lengthy political vicissitudes that had bedevilled its production. It served a useful purpose, however: it had become the basic pattern on which the four rigid airships for the Admiralty were later to be based. The first of these **'23' class** airships, **HMA No. 23**, was subsequently delivered from Vickers Limited, Barrow-in-Furness, to Pulham on 15 September 1917.

Design work had started in June of the previous year, the first flight being planned for that autumn, but considerable redesign had to be carried out when the original specification resulted in a vessel that was something like 3493 kg (7,700 lb) too heavy, the greater part of this excess being attributable to the choice of engines.

The first trial flight of No. 23, four days after delivery, turned out to be something of an anticlimax, for it was clear that she too was at least obsolescent, as might be expected from the original design source, and her modern counterparts had a lifting capacity some nine times greater than that of which she was capable. It is hardly surprising, therefore, that the planned total of 10 airships of this type was finally cut back to six, while No. 23 was relegated to training duties. The other units of the class were **HMA No. 24** (Beardmore), **HMA No. 25** (Armstrong Whitworth), **HMA R26** (Vickers), **HMA R27** (Beardmore) and **HMA R29** (Armstrong Whitworth), the last pair being of the improved **'23X' class** without an exterior keel. No. 26 was the first to receive the 'R' prefix for rigid airships.

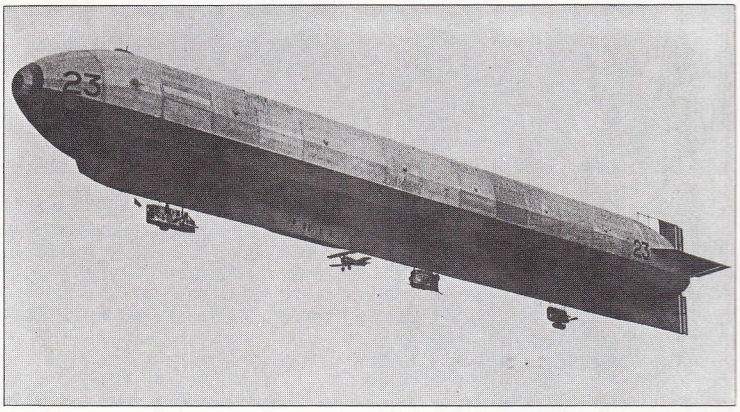
Mindful that in the mid-months of 1918 there was a possibility of aerial confrontations between airships of the opposing nations, experiments were carried out with Sopwith Camel aircraft suspended beneath the envelope of No. 23; the plan in the event of an attack was for the two fighters to be released to defend the mother vessel. There was no provision at the time for the aircraft to be reclaimed.

In the spring of 1919 No. 23 was strengthened for tests at a mooring mast, but before they could be carried out she was broken up in September.

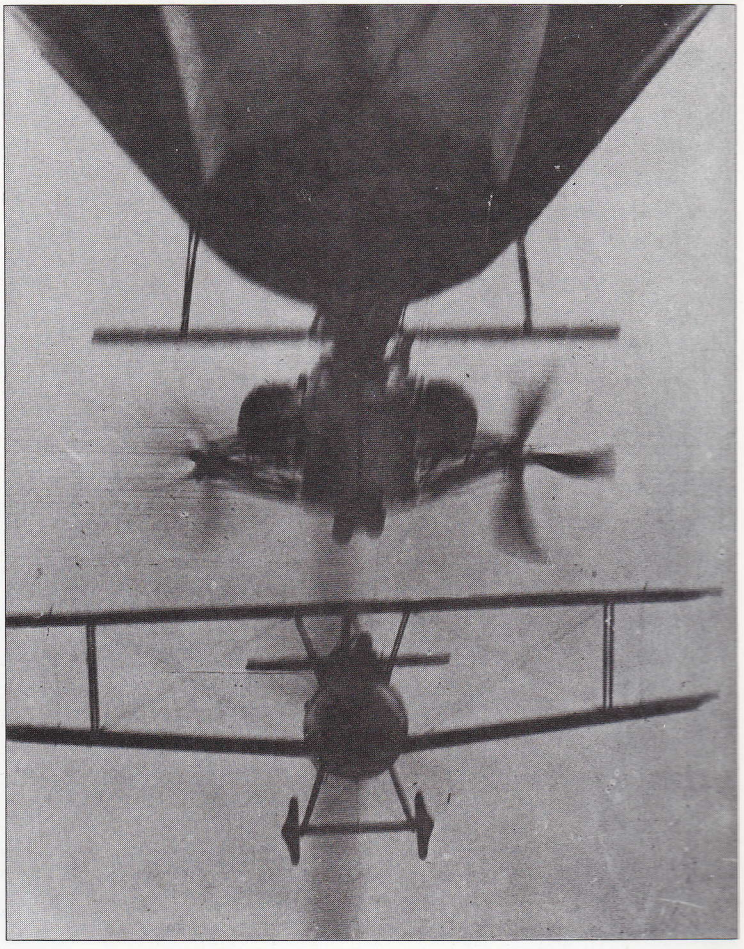
Specification

HMA No. 23

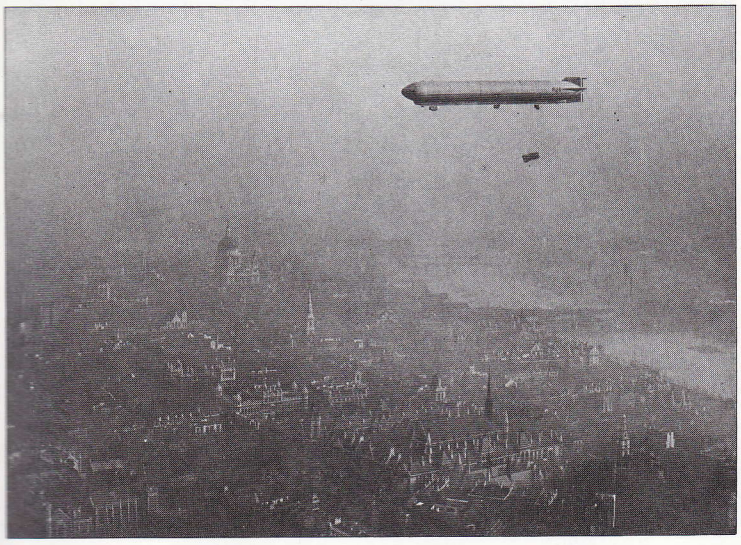
Type: naval training airship
Powerplant: four 186.4-kW (250-hp) Rolls-Royce Eagle III 12-cylinder water-cooled piston engines
Performance: maximum speed 84 km/h (52 mph); service ceiling 914 m (3,000 ft); range 3219 km (2,000 miles)
Weight: useful lift 6000 kg (13,228 lb) including four 45-kg (100-lb) bombs
Dimensions: diameter 16.15 m (53 ft 0 in); length 163.07 m (535 ft 0 in); volume 26674.4 m^3 (942,000 cu ft)
Armament: provision for 7.7-mm (0.303-in) Lewis gun on free mounting above forward portion of hull, plus bombs



Based on the earlier No. 9 of 1916, the No. 23 and its successors were constructed by Vickers at Barrow-in-Furness. The R23 was delivered to the Navy at Pulham on 15 September 1917. It is seen here with a Sopwith 2F.1 Camel underneath and a partially stripped upper fin.



In 1918, No. 23 was used for a series of experiments whereby a pair of Sopwith Camel aircraft were air-launched from under the hull, trials that were echoed in the United States and the Soviet Union. The British aircraft involved were drawn from No. 212 Squadron, RAF.



With an observation balloon in the distance, R26 passes over the City of London in 1918. She was the first of five additional vessels of the '23' class ordered for the Royal Naval Air Service in January 1916, to be built by Vickers at Barrow-in-Furness.

Observation Balloons

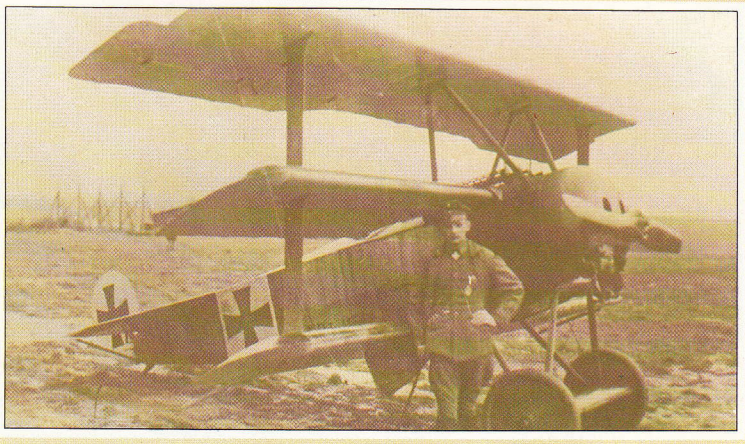
As the rival armies faced each other from their trenches, both sides began to employ captive balloons for reconnaissance. Enemy positions could be studied in minute detail, officers could see the terrain over which they were to attack, and artillery fire could be zeroed in. Inevitably, the balloons themselves became targets for attack.

The use of balloons to gather information is old, for such devices were employed during the French Revolution and later by Napoleon on some of his campaigns. Experiments had been conducted in the USA as early as 1784, but it was not until 1840, during the Seminole War, that anything in the nature of an organized balloon corps was planned, and it is interesting to note that in 1863 a youthful Count von Zeppelin made his first flight in the USA.

In the UK, a small balloon factory was established at the Chatham School of Military Engineering as a result of trials that had been begun in 1878 at Woolwich Arsenal, and one year later the British Army had five balloons on charge, complete with winch waggons and horse-drawn gas carts. Small wonder therefore that observation balloons were to be seen above the battlefields of South Africa, Bechuanaland and the Sudan before the end of the century.

At much the same time, experiments in Germany resulted in the Drachenballon combining the principles of both balloon and kite, a design that was used in numbers to observe and direct artillery fire in the opening months of World War I. British reaction was to copy the design or use the unsuitable spherical type; the same type was used by France, which had decided to abandon the use of military balloons in 1912. The final solution was the work of a French officer, Albert Caquot, who designed a new type, albeit based on the German pattern, equipped with three stabilizing fins that enabled it to be used in winds of speeds up to 100 km/h (62 mph).

There were four standard types of Caquot balloon with varying capacities: the smallest was the Type P of 750-m^3 (26,486-cu ft), followed by the Type P2 of 820-m^3 (28,958-cu ft), the Type M2 of 930-m^3 (32,842-cu ft) and the Type R of 1000-m^3 (35,314-cu ft). The first three could each carry aloft two men, while the Type R could support three men in its basket. The first two types were used by the French army and also by the French navy from small vessels, while the Type R was capable of being flown from capital ships at altitudes up to 1000 m (3,280 ft), and the smaller M2 to something like half that figure. Five months before the end of World War I the French navy had 200 of all types of balloon on charge, although only 24 vessels were equipped to fly them.

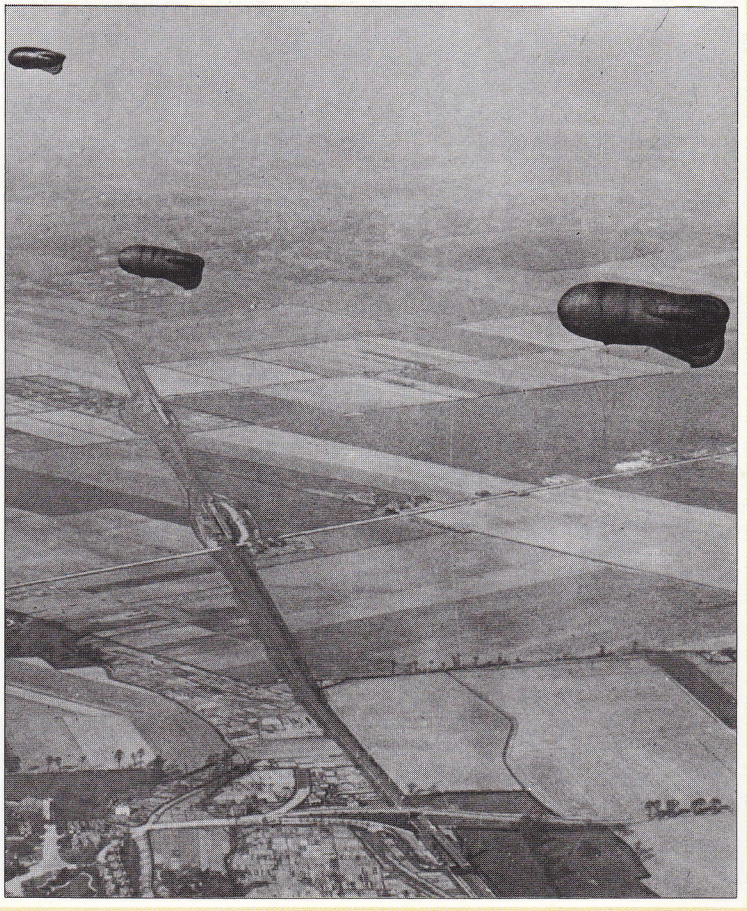


Destroying the heavily-defended balloons called for a high degree of courage, some pilots specializing in the work. One such was Heinrich Gontermann, who accounted for 18 before being killed.

Caquot balloons were soon adopted by France's allies, and over land were capable of being flown to an altitude of 1000 m (3,280 ft) even in a wind of Force 9 (about 100 km/h/62 mph) if the work demanded, both day and night. The observers were very simply equipped, with binoculars and an ordinary field telephone with which to report to the ground what they saw, and since, as might be expected, captive balloons provided a tempting target for enemy aircraft, those aboard also carried parachutes hung over the side of the basket to provide a means of escape. The parachute was opened by a static line as the wearer jumped.

The Germans generally carried out their observation work in the early morning, the British and French in the afternoon. In this way the Germans had the advantage of the morning sun behind them, the afternoon sun fulfilling the same function for the Allies, who as time passed thankfully bade farewell to their Drachens, which more than one observer later recalled as 'damnably unsteady'.

A balloon is used here to train officers in parachute training. Mastery of this was essential if the Caquot could not be winched down sufficiently swiftly in the event of an attack by aeroplanes. Such a victory was considered equal to that over an aircraft.



A row of tethered Caquot balloons clearly show their outlines. These were more elongated fore and aft than those of the World War II barrage balloons used to protect land targets, although these and the present-day parachute training balloons are all related.

That the work made extreme demands on the occupants of the frail suspended baskets is easy to overlook: not only were the duties carried out under extremes of temperature and, if the light was good enough, exposed to the vagaries of the weather, but there was always the danger of attack by opposing fighters. Despite the fact that severe measures were taken to protect the balloons, both sides developed specialists in this type of attack, the Belgian Willy Coppens and the German Heinrich Gontermann being two prime examples. Indeed, the demands of the balloon observers' job had some surprising results, such as the officer who was surprised at the coarseness of his language after a stint aloft, which was accompanied by a stammer and complete deafness that lasted some five minutes after landing. In an attempt to counteract the effects of a swift descent from altitude, some wings developed their own techniques such as that employed by No. 2 Wing, which was to pause at 4270 m (14,000 ft) even if the balloon was being winched down under attack; this was an unnerving practice for passengers unused to balloon work, such as the senior officers taken aloft to become familiar with the terrain over which they were shortly expected to advance!

Observation balloons were flown at first from a variety of motor vehicles, France using either the 32-hp (23.9-kW) or 60-hp (44.7-kW) Delahaye engine driving a Saconney winch, although from 1917 these were replaced by winches of Caquot's own manufacture driven by a 70-hp (52.2-kW) de Dion Bouton that was capable of bringing its charge down at a speed in the region of 6 m (20 ft) per second.

With the Allied observation line running practically the entire length of the Western Front, the demand for crews was of course high, and to meet this the British army set up a series of depots and schools in England at such centres as Larkhill, Lydd and Roehampton, while for a time even the Oval cricket ground was used. At these, and at the artillery schools attended by some observers, special techniques (such as that demanded by the need to keep one's glasses on a target however much the balloon might roll, jerk, leap, soar or sink) were learned. Other techniques (such as that of taking the telephone cable up over the trapeze before running it to the ground, so that it did not foul the parachute of an observer escaping from a balloon set alight by attack on the Caquot) had to be learned at the front as Caquots replaced the Drachens in which the telephone lines were taken direct from the basket to the main cable.

A Caquot captive observation balloon is seen above ruins on the Ypres salient on 27 October 1917. To train personnel, the Royal Flying Corps had opened two training schools in July 1916, plus a balloon depot. There were plans to form two new balloon sections per week.

Above: A Belgian Drachen-type kite balloon is seen in Flanders in 1914. The similar Parseval-Sigsfeld pattern had been in use by the German army since 1898 despite its attendant handling problems, in order to direct gunfire and to report its effects.

Right: Willy Coppens, Belgian balloon-attacking specialist, stands in front of his Hanriot HD.1 of 9ème Escadrille. Severe injuries from the dum-dum effect of an incendiary bullet received while attacking a balloon in October 1918 cost him a leg. He had accounted for 26 enemy balloons.

UK

'NS' class

Another trefoil-section vessel, the **'North Sea'** or **'NS'** class was the last non-rigid airship type to be built for the Royal Navy, the first being ordered in January 1916 and delivered to the naval air station at Pulham in February 1917.

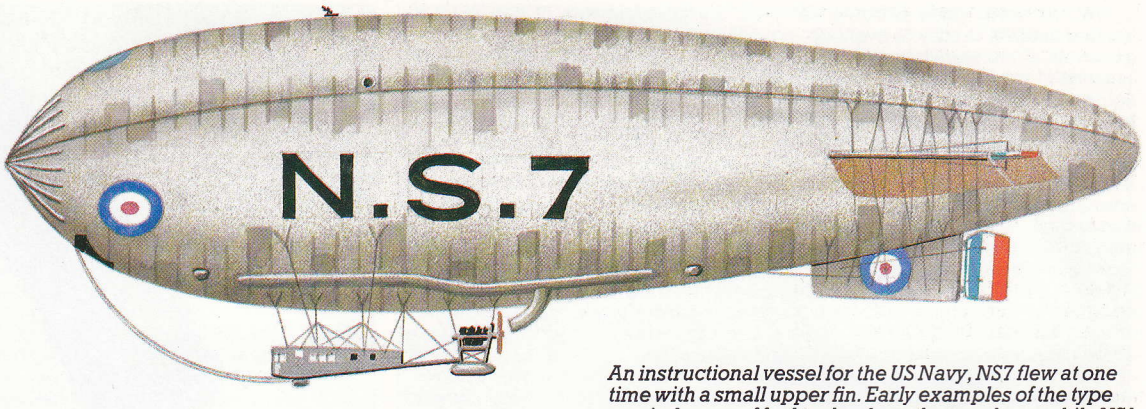
The original idea had been for an airship which could carry out convoy duties and also co-operate with naval surface vessels, a concept that was never put into practice, the whole 'NS' fleet being used for patrol duties.

One reason for this decision was the trouble that was experienced with the Rolls-Royce engines first fitted, the problem lying with the over-long shafting, about 3.05 m (10 ft) in length. It was only when this complicated transmission and the engines had been exchanged for direct-drive Fiats, that the type was able to prove its usefulness; previously only 18 were delivered, a mere 12 being with operational units.

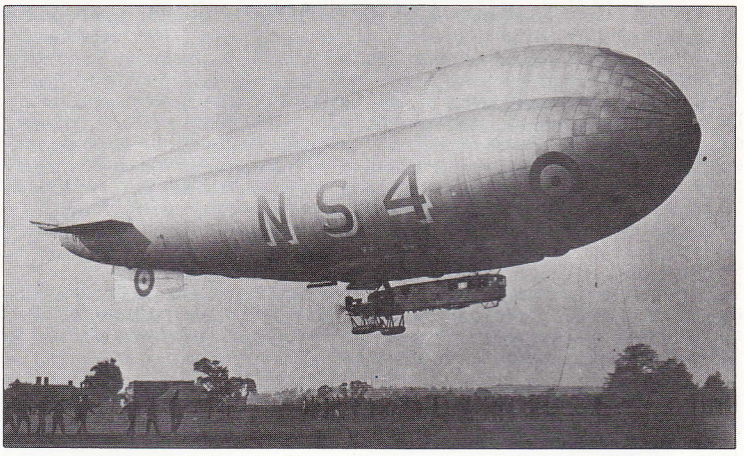
Although a variety of car configurations was encountered, all of them were of similar lines, with the powerplant mounted in a separate nacelle joined to the crew quarters by a wooden catwalk. This forward part of the car had been designed with some consideration to the comfort of its occupants. Such additions as a chart table and bunks were now essential, since the 10 men aboard were expected to operate as two watches, five being on duty while the remainder rested.

From July 1917 the small number of North Sea airships then in use were all based on the Firth of Forth at East Fortune, but by the end of the war over 100 had seen service. An early example **(NS14)** had gone to the United States and become A5580, while **NS6** became a familiar sight to Londoners as a result of its frequent appearances over the capital; and in 1919 **NS11** established an endurance record for a non-stop cruise of 6437 km (4,000 miles) in 101 hours.

Although its primary duty was to attack U-boats with its cargo of bombs, an historic use for **NS7** and **NS8** was to make up the aerial force with the British fleet sent to accept the surrender of the German naval forces on 21 November 1918. All convoy protection and coastal patrol airships carried about 181 kg (400 lb) of bombs with which to attack U-boats, but the useful load varied with the water ballast carried. Earlier models of the 'NS' class were powered by a pair of 186.4-kW (250-hp) Rolls-Royce engines, while latterly **NS12** to **NS18** received 223.7-kW (300-hp) Fiats.



An instructional vessel for the US Navy, NS7 flew at one time with a small upper fin. Early examples of the type carried a row of fuel tanks along the envelope, while NS1 had an enlarged fin and rudder. NS3 retained such a fin but the rudder was discarded.



NS (North Sea) non-rigid No. 4 served at both East Fortune and Longside airship stations. There were detail differences in the car design, some having an unfaired connection to the motors. They were larger than the 'Coastal' type but had a trefoil section in common.

Specification
'NS' class
Type: convoy escort airship
Powerplant: two 186.4-kW (250-hp) Rolls-Royce Eagle III V-12 or 193.9-kW (260-hp) Fiat A.12 six-cylinder water-cooled piston engines
Performance: maximum speed 93 km/h (55 mph); service ceiling about 7010 m (23,000 ft); range 4828 km (3,000 miles)
Weight: useful lift 3810 kg (8,400 lb)
Dimensions: width 17.30 m (56 ft 9 in); length 79.86 m (262 ft 0 in); volume 10194 m^3 (360,000 cu ft)
Armament: four or five 7.7-mm (0.303-in) Lewis machine-guns on free mountings, plus bombs

FRANCE

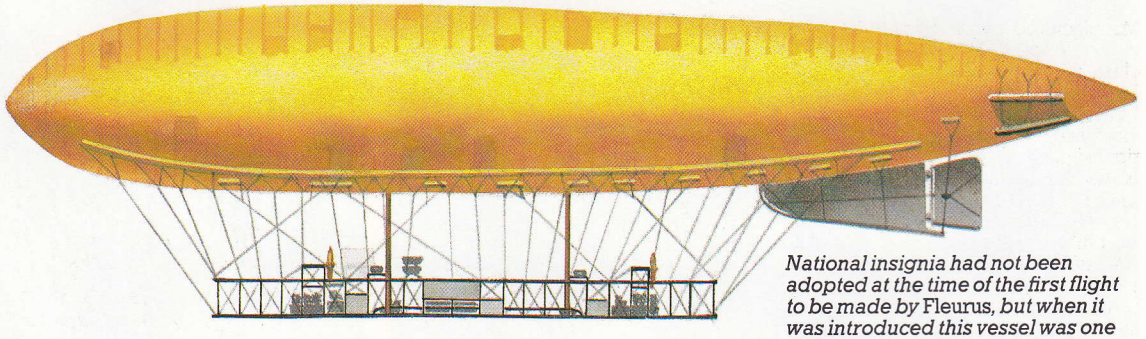
Chalais-Meudon *Fleurus*

When war broke out in 1914, French airship equipment was entirely of the non-rigid pattern, and it was one of these that made history in becoming the first Allied airship to carry out an air raid. This, despite its age, was the ***Fleurus***, which had been built (like all French army craft of the lighter-than-air type) in the workshops at Chalais-Meudon two years earlier, being regarded as a smaller sister ship to *L'Adjutant Vincenot* (C.B.IV).

Interestingly, the *Fleurus* (or **C.B.V.** as it was officially known), had for the period a good aerodynamically efficient shape as it had been designed as a result of wind tunnel tests conducted at the Eiffel laboratory. While these results were applied to the contours of the envelope, Clément-Bayard was responsible for the design of the motor and the gondola, hence the initials of the alternative designation.

During the last year of peace, great use was made of the vessel, which participated in the army manoeuvres of that summer. It also left its base at Pau on 23 September at the beginning of a flight to Saint-Cyr, a journey which it completed in 16 hours, averaging a speed of 54 km/h (33.7 mph), rather less than its maximum, for the distance of 680 km (423 miles) at an altitude never more than 1000 m (3,281 ft).

When making its historic raid from Verdun, the *Fleurus* was officially an army airship, there being no equivalent naval air arm; but with effect from 1 January 1917 this was rectified and the army vessels were handed over to establish the new branch of the navy. Of the six non-rigids involved, four were at once deployed for sea patrol in much the same manner as the British 'North Sea' and similar types, but by now the C.B.V was five years old and obsolescent, so that with another airship it was relegated to training duties. The base for this work was far from the area where the newer airships operated – North Africa's Mediterranean coast – being instead no further afield than Rochefort. It was here the *Fleurus* ended its days when France's most historic non-rigid of World War I was destroyed in a fire as a result of an air raid in June 1918.



National insignia had not been adopted at the time of the first flight to be made by Fleurus, *but when it was introduced this vessel was one of the earliest in France to be thus marked.*

Specification
Chalais-Meudon *Fleurus*
Type: army bombing airship
Powerplant: two 59.7-kW (80-hp) Clément-Bayard four-cylinder water-cooled piston engines
Performance: maximum speed 58 km/h (36 mph); service ceiling 1000 m (3,281 ft); range 680 km (423 miles)
Weight: useful lift 5200 kg (11,464 lb)
Dimensions: diameter 12.40 m (40 ft 8.2 in); length 77.00 m (252 ft 7.5 in); volume 6500 m^3 (229,546 cu ft)

ITALY

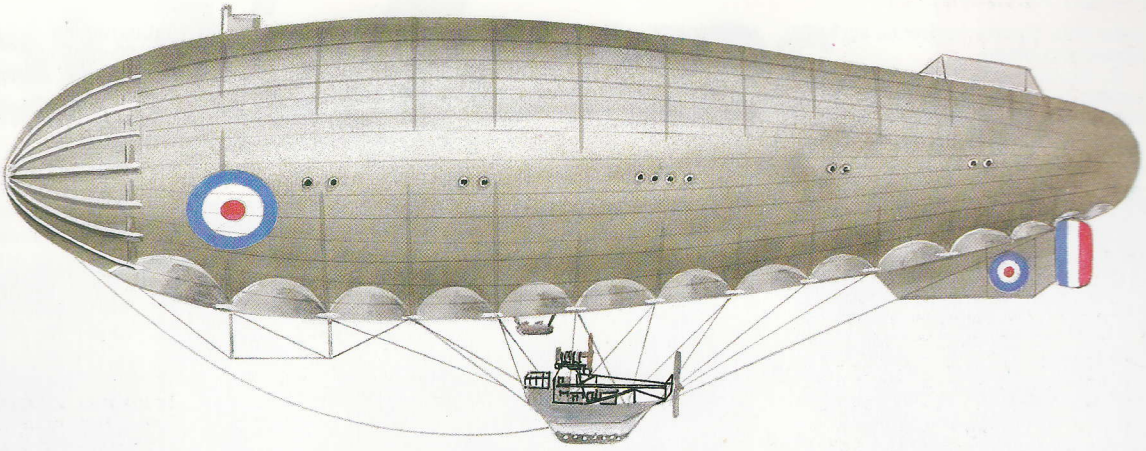
'M' class

The **'M' class** airships of semi-rigid design were extensively used by both the army and navy in Italy, and with them a total of almost 600 wartime sorties of various types were flown. A single example, later designated the **SR.1**, was ordered by the Admiralty for use by the Royal Navy in 1918 and flown from Italy on 28 October of the same year, but it was used only for experimental comparison with various British non-rigid coastal types.

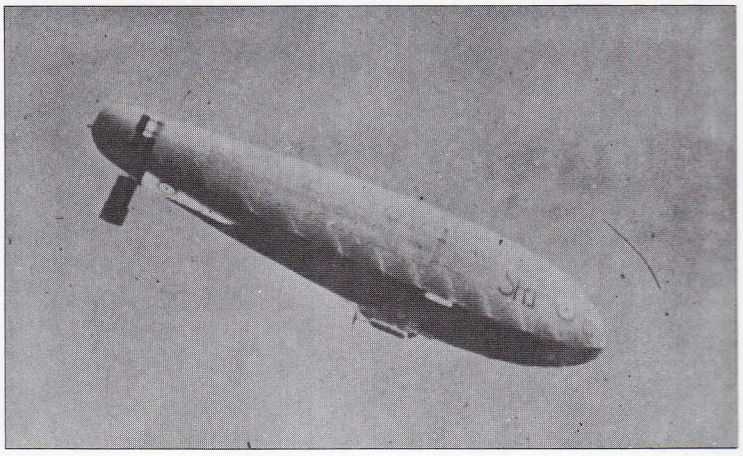
Originally conceived for attacks on targets in Austria-Hungary, the design received special attention with regard to its altitude capability, since the rail junctions and docks which would be attacked were well defended by anti-aircraft guns. Additionally, several innovations were incorporated, such as the manner in which the keel was laid out to support the tailplane and also to meet the bows; wires from the keel connected it to canvas girdles, while bands about the circumference of the envelope in conjunction with parabolic wires took the weight of the car.

As a precaution against excessive leakage the envelope was divided into six sections internally, and the entrance of air to maintain the shape of the covering was through the nose, via a valve containing shutters operating on the principle of a venetian blind. A feature of the motors was the long shafting to the variable-pitch reversible propellers, something of an achievement since the history of motors mounted on outriggers at each side of a gondola (with a consequent demand for complex linkage) had not been happy.

'M' class airships operated by the Italian army were of the standard scouting version, but those with the navy were regarded as special in that they were equipped for bombing; the load of 1000 kg (2,205 lb) was a useful one which might have to be carried on a sortie of six-hour duration, this being the reason why no particular attention was paid to achieving a higher maximum speed. Meanwhile, the SR.1 in British service was the target of much criticism, not so much for its capability as for the high costs involved in the trials. The type remained the sole example in the UK, and was not adopted for general use; its designation indicated the type of design, namely semi-rigid, and it was powered by one 149-kW (200-hp) SPA 6A and two 164-kW (220-hp) Italia D.2 engines, all of them water-cooled.



Above: Marked by their prominent nose reinforcement, 'M' class airships had biplane horizontal surfaces and elevators supporting outrigged rudders. Photographs show that the navy later marked SR.1 with its number aft of the cockade.



The Royal Navy's semi-rigid No. 1 (SR.1) was similar to those of the same (M) class that were used extensively by the Italian army and navy during the war years. British experiments with this vessel were designed to compare it with non-rigid 'blimps'.

Specification
'M' class
Type: bombing airship
Powerplant: two 186.4-kW (250-hp) or two 208.8-kW (280-hp) Itala-Maybach four-cylinder water-cooled piston engines
Performance: maximum speed 80 km/h (50 mph); service ceiling 2000 m (6,562 ft); range 840 km (522 miles)
Weight: useful lift 3800 kg (8,378 lb)
Dimensions: diameter 17.00 m (55 ft 9.3 in); length 83.00 m (272 ft 3.7 in); volume 12500 m^3 (441,434 cu ft)
Armament: one 7.7-mm (0.303-in) Lewis gun or equivalent on free mounting above nose of envelope, plus bombs

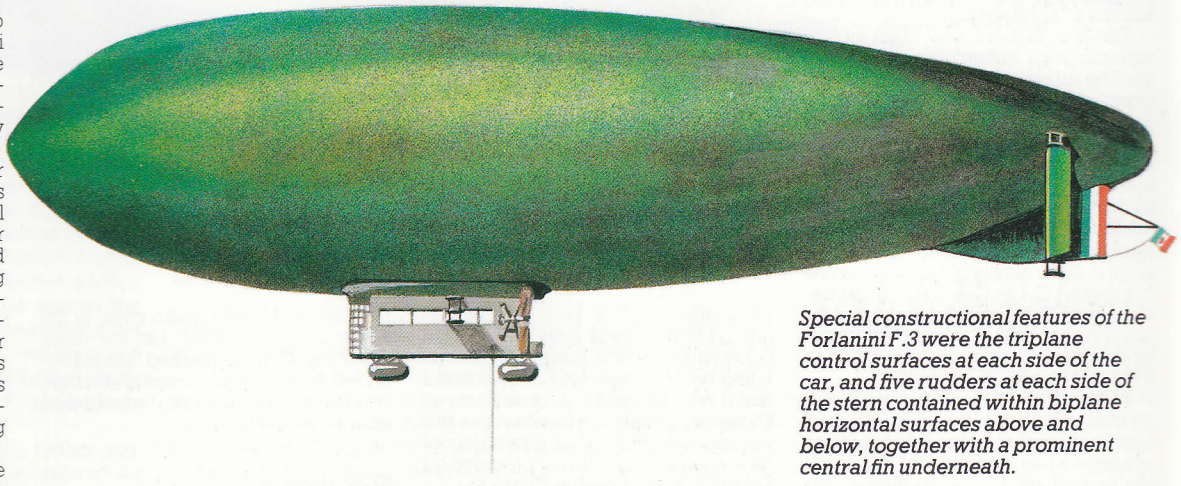
ITALY

'Forlanini' class

Manufactured by the Società Leonardo da Vinci in Milan, the **'Forlanini' class** airships (designed by Enrico Forlanini and the firm's engineer Luigi Crescentini) may be regarded as the most successful of the Italian semi-rigid vessels, winning a number of records during the years immediately preceding World War I.

Early versions had carried their structural girder externally, but this was eventually placed within the hull as a truss from which the central car with its crew compartment, motors and flotation bags protruded, the leading edge being glazed and an unusual triplane set of control surfaces being carried at each side of the **F.3**. To the rear of the car the propellers, arranged as pushers, were carried on outriggers with an extended linkage to the engines, the reversible propellers being capable of variable pitch.

An interesting design feature of the envelope was its double surface with a space between the inner and outer fabric, which served as a ballonet to maintain the shape of the envelope. In addition a climbing well was included together with a ladder by which to gain access to a platform on top of the hull.



Special constructional features of the Forlanini F.3 were the triplane control surfaces at each side of the car, and five rudders at each side of the stern contained within biplane horizontal surfaces above and below, together with a prominent central fin underneath.

There were five initial 'Forlanini' airships with progressively improved performance, the best showing a rate of climb of 1000 m (3,300 ft) per minute. One such airship setting up an endurance record of eight hours, in the course of which the average altitude maintained was 3960 m (12,992 ft) although at one time 5335 m (17,503 ft) was attained.

Perhaps the most unusual feature of the Forlanini was the construction of the tail. This did not terminate in the conventional cruciform pattern but had instead a robust ventral fin of thick section. To each side of this and below the centreline a series of high aspect ratio rudders was carried (five to a

side) with biplane horizontal surfaces above and below.

A considerably smaller Forlanini airship was the **'P' class** (Piccolo, or small) with a fixed vertical fin and outrigged rudders at the ends of very wide span elevators. This model was 63.0 m (206 ft 8.3 in) in length, with a diameter of 12.0 m (39 ft 4.4 in).

Specification
Forlanini F.3

Type: sea patrol and bombing airship
Powerplant: two 74.6-kW (100-hp) Fiat A six-cylinder water-cooled piston engines
Performance: maximum speed 80 km/h (50 mph); service ceiling 5480 m (17,979 ft); range 650 km (404 miles)
Weight: useful lift 2720 kg (5,997 lb)
Dimensions: diameter 20.34 m (66 ft 8.8 in); length 90.51 m (296 ft 11.4 in); volume 13800 m^3 (487,343 cu ft)

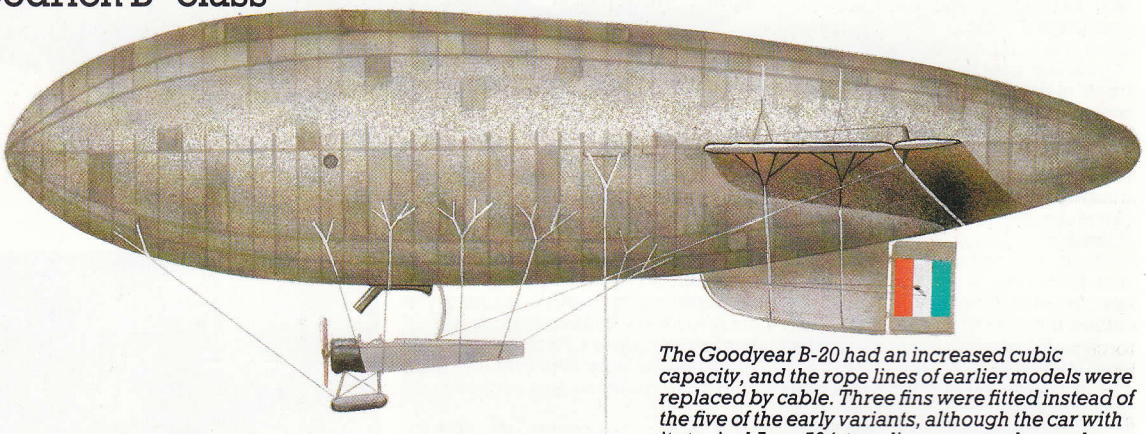
USA

Goodyear/Goodrich 'B' class

It was in 1915 that the US Navy took on charge its first non-rigid coastal patrol airship, a type that was based on the information coming out of Germany and built by the Connecticut Aircraft Company as the DN-1. The **'B' class** which followed the failure of this first design was more closely based on that of British airships used for similar work, the first orders going to Goodyear in March 1917. However in all fairness it should be said that the 'B' class was in no way conceived as a replacement for the earlier type, which had in fact not flown when design work had begun on the Goodyear.

Although the 'B' class shared some of the British features, such as the use of an aeroplane fuselage as its car, there were differences such as the absence of an upper fin, though some 'B' class vessels did have this feature. There were several other differences between individual airships within the same class.

Further variations took place after the first nine examples (**B-1** to **B-9**) had been built by Goodyear, production then being undertaken by the B.F. Goodrich Co. The earlier airships had employed the finger-patch method of fastening the car lines to the envelope, which measured 9.60 m (31 ft 6 in) in diameter, and 48.77 m (160 ft 0 in) in length, but the 'B' class from **B-10** to **B-14** were longer and of greater girth.



The Goodyear B-20 had an increased cubic capacity, and the rope lines of earlier models were replaced by cable. Three fins were fitted instead of the five of the early variants, although the car with its typical Avro 504-type lines was unchanged.

It is interesting to note that the later variants (of which two only were built by Connecticut) were the shortest of all but with a greater-diameter envelope, and that the belly-bands which had replaced the finger-patches on the Goodrich were retained.

The B-10, in common with others of its class, proved a sound and reliable vessel; the two-man crew were fairly comfortably accommodated in the individual cockpits of the suspended fuselage, on which the landing gear had been replaced by rigidly-mounted air-filled flotation bags.

The B-10 was among the first batch of Goodyear/Goodrich vessels which were delivered between June 1917 and July of the following year, the former date marking something of a record since the first of the 'B' class had made its maiden flight at the end of May, only two weeks after the declaration of war on Germany by the United States. The total number of vessels of this type delivered was only 16, but three were later reconstructed and given new numbers **B-17** to **B-19**. The final **B-20** was sufficiently different, with increased gas capacity and an OXX-3 motor, to be considered a new design.

Specification
Goodrich B-10
Type: coastal patrol airship
Powerplant: one 74.6-kW (100-hp) Curtiss OXX-2 eight-cylinder water-cooled piston engine
Performance: maximum speed 80 km/h (50 mph); service ceiling 2134 m (7,000 ft); endurance about 16 hours
Weight: useful lift about 2268 kg (5,000 lb)
Dimensions: diameter 10.06 m (33 ft 0 in); length 50.90 m (167 ft 0 in); volume 2265.3 m^3 (80,000 cu ft)
Armament: one or two 7.62-mm (0.30-in) Lewis machine-guns

USA

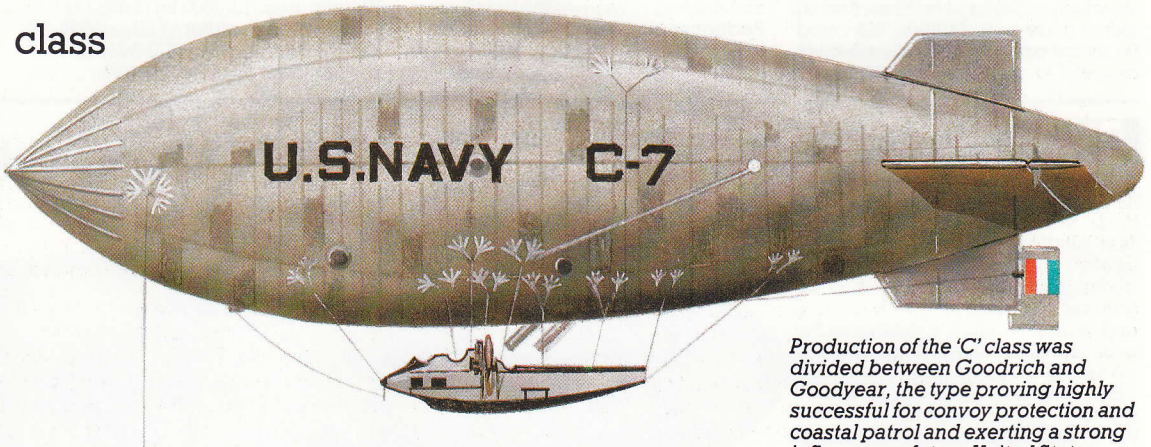
Goodyear 'C' class

The **Goodyear 'C' class** airship was a type which must be counted the most successful design ever produced for the type of work envisaged: the **C-7** became part of technical history and the type as a whole, although of non-rigid pattern, influenced the next generation of rigid vessels.

The first flight of a 'C' class airship took place on 30 September 1918, this and the subsequent five airships being produced by the Goodyear Tire & Rubber Company of Akron, Ohio, where a training establishment and a hydrogen plant had already been set up under contract with the US Navy on 29 May 1917; the 20 trainees in each intake had the advantages of permanent barracks.

The six vessels produced were numbered **C-1** to **C-8**, the omitted designations **C-2** and **C-6** being used for some reason with **C-9** and **C-10** for the quartet of airships of the type ordered from the Goodrich company.

Although the work performed by the 'C' class units proved it an outstanding airship design, the type came into use at a time when World War I was nearing its end, so it is to the design features of the class that one must look for interest. Most obvious of these was the four-crew streamlined car with an engine and pusher propeller mounted at each side. The C-7's claim to history rests on a single incident when, on 1 December 1921, it became the first airship in the world to fly with helium substituted for the normal hydrogen lifting gas. The test was so successful that it was decided that henceforth all US airships would use this inert gas as a fire precaution despite the small loss of lift in comparison with that provided by lighter but inflammable hydrogen.



Production of the 'C' class was divided between Goodrich and Goodyear, the type proving highly successful for convoy protection and coastal patrol and exerting a strong influence on future United States design. A boat-like car distinguished all the series.

Other records held by the 'C' class include its use for the first successful release of an aeroplane from a non-rigid airship, and by becoming the first airship to make a coast-to-coast US crossing, this being achieved by one of the pair that were given over to US Army control in 1921. On the other hand the **C-5**, earmarked for a projected transatlantic crossing attempt, was lost in a storm when it was ripped from its moorings.

Specification
Goodyear C-7
Type: coastal patrol and convoy escort airship
Powerplant: two 149.1-kW (200-hp) Hall-Scott L-6 eight-cylinder water-cooled piston engines; reports also mention the 111.9-kW (150 hp) Wright-Hispano as an alternative but supportive evidence is lacking
Performance: maximum speed 97 km/h (60 mph); service ceiling 2438 m (8,000 ft); range about 4828 km (3,000 miles)
Weight: useful lift about 2,404 kg (5,300 lb)
Dimensions: diameter 12.80 m (42 ft 0 in); length 58.52 m (192 ft 0 in); volume 5125.3 m^3 (181,000 cu ft)
Armament: one 7.62-mm (0.30-in) Lewis machine-gun

Armed Forces of the World

Soviet Air Forces

Part 1

As one of the two most powerful nations on the globe, the Soviet Union possesses an air force of immense proportions, armed with aircraft whose technological level is rapidly increasing. However, it would be more correct to credit these combat and support machines to several air forces, for Soviet military aviation has developed along a path different from that normally found in the West.

Thus, there is a Strategic Rocket Force (Raketnyye Voyska Strategicheskovo Naznacheniya) operating long-range missiles; an air defence arm with a manned interceptor component, as well as anti-aircraft weapons; a 'traditional' air force, with bomber, tactical and transport elements; a semi-autonomous army air force; and a sizable naval air force with such components as nuclear-armed heavy bombers.

Since 1981, some of these forces have been reassigned in a new plan which more closely resembles what is expected to be the Soviet mobilization configuration. At its apex is a new command, Headquarters of the Air Armies of the Soviet Union, responsible for co-ordination of strategic and tactical forces. Below this stratum are Theatres of Military Operations, designated as the basic level of command in war, each with an Air Army. There are five Air Armies, each equipped with a strategic bomber, an air defence and a transport element, plus between three and five Air Forces of the Military District, perhaps better described by their previous name of 'Tactical Air Armies'.

Air defence has always been a preoccupation of the Soviet Union (particularly since the devastating German assault in 1941), and so this function is assigned to a separate force known as the Troops of Air Defence (Voyska Protivovozdushnoy Oborony), which is directly responsible to the Minister of Defence. Voyska PVO, now with some 500,000 personnel, has expanded with the needs of the day, adding the Zenith Rocket Troops (Zenityye Raketnyye Voyska) with their 10,000 surface-to-air missile (SAM) launchers; Radio-Technical Corps (Radiotekhnicheskiye Voyska) to operate the vast and comprehensive detection and communications network with its 5,000 radars; Anti-Space Defence (Protivokosmicheskaya Oborona); and Anti-Rocket Defence (Protivoraketnaya Oborona). In 1980, as part of the re-structuring of Soviet forces, it added the army's SAM and anti-aircraft gun force, Troops of Air Defence of the Ground Forces (Voyska Protivovozdushnoy Oborony Sukhopputnykh Vosk).

SAM production is at the level of about 50,000 missiles per year, providing for replacement of the obsolete SA-1 and augmentation of the ageing SA-2 and SA-3. Giant SA-5s provide long-range defence (up to 300 km/185 miles) and introduction is progressing of the SA-10 and SA-12. The former, a Mach 6 weapon, is claimed to be effective against the cruise missiles which currently form one pillar of the West's deterrence, whilst the SA-12 will engage a target at any height from 30 to 30500 m (100-100,000 ft) up to 100 km (62 miles) from its launcher.

Manned interceptors are flown by a further section of the Voyska PVO, designated Aviation of Air Defence (Aviatsiya PVO). Once autonomous on a national scale, this now has its aircraft controlled by the Theatre of Military Operations HQ. Below this administrative level, the structure remains unchanged, and the several air defence zones within each of the 20 Soviet Military Districts continue to direct their fighters as before.

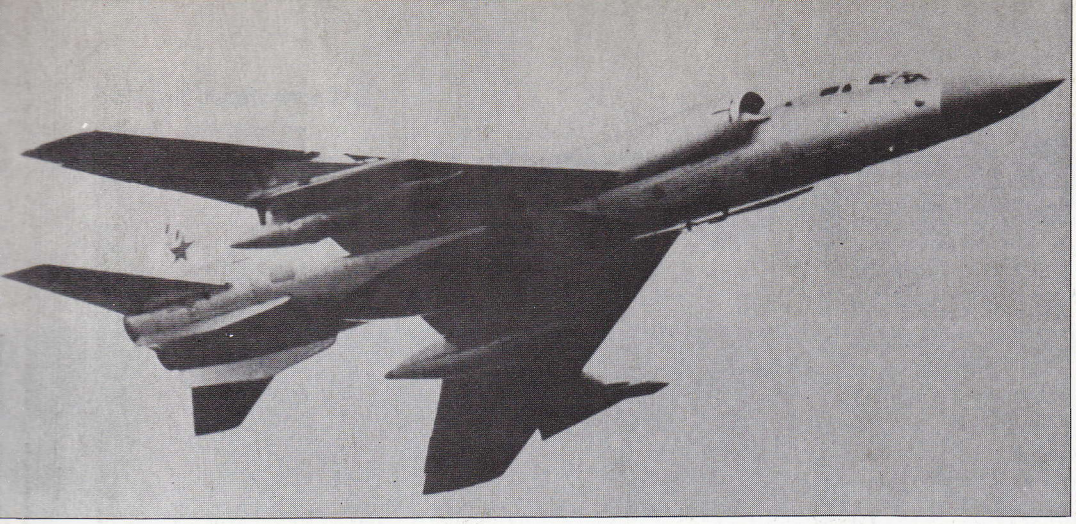
The Mikoyan-Gurevich MiG-23 'Flogger' now represents the mainstay of the Soviet air forces, with over 2,700 of all versions in service. The type is employed as a multi-role fighter, being able to fill the air-defence and ground attack roles well, although various versions are specifically produced for these roles.

A profound upgrading programme is now under way for Aviatsiya PVO to transform its current strength of some 1,250 aircraft (this figure excluding Frontal Aviation's tactical interceptors, of which about 2,000 are available to defend the USSR). There remain about 500 Sukhoi Su-15 'Flagons' and Yakovlev Yak-28 'Firebars' from earlier generations of fighters, of which all will disappear during the next two or three years. Competent for the interception of high-level intruders, they (or more accurately, their radar) have been rendered obsolete by the low-flying threat.

Today's requirement is for the look-down/shoot-down capability provided by modern, pulse-Doppler radars and associated air-to-air missiles (AAMs). First steps in this direction resulted in the Mikoyan-Gurevich MiG-23 'Flogger' and MiG-25 'Foxbat', some 700 of which are in Aviatsiya PVO service. Air-defence versions of the 'Flogger' augment their internal 23-mm cannon by a typical AAM fit of four R60s (NATO designation AA-8) and two short-range, heat-seeking R23s (AA-7s). The AA-7 exists in both radar-guided and heat-seeking (infra-red) forms, and has a range of some 32 km (20 miles).

Earlier versions of the 'Foxbat' lacked the ability to engage low-level targets, because the aircraft had been hastily designed to combat a threat which failed to materialize, namely the North American B-70 Valkyrie. Almost matching its potential adversary's Mach 3 performance, the 'Foxbat' is the world's fastest armed combat aircraft in squadron service. In the MiG-25M 'Foxbat-E', the original (and very powerful) Fox Fire radar has been replaced with a modified unit which provides look-down/shoot-down performance equivalent to that of the 'Flogger-B'. Four AAMs are carried, being a mixture of AA-7s, AA-8s or the 37-km (23-mile) range AA-6 in radar-guided or infra-red homing forms.

While Aviatsiya PVO will retain its 450 'Floggers' and 250 'Foxbats' for the foreseeable future, some 600 modern fighters are expected in the inventory by 1988. The first of these, the MiG-31 'Foxhound', entered service in 1983 and has probably been issued to at least three 30-aircraft regiments by now. Evolved from the MiG-25, it has leading-edge root extensions for increased agility, but is expected to operate in the same mode as the RAF's Panavia Tornado F.Mk 2: striking down at targets from long-range, high-level cruise flight, perhaps in conjunction with an AWACS aircraft.



The largest fighter ever to see service, Tupolev's mighty Tu-28P 'Fiddler' has a combat range of 4989 km (3,100 miles) and is used principally for interception over the Arctic wastes of the North. This early 'Fiddler-A' carries two of the AA-5 'Ash' air-to-air missiles which can be produced in both radar homing and IR rounds.

'Foxhound' is a two-seater, whose rear occupant handles the pulse-Doppler radar with its multi-target tracking capability. Up to eight radar-homing AA-9 AAMs are carried, and the fact that they have (under experimental conditions) been launched from 6100 m (20,015 ft) and destroyed a target 20 km (12.5 miles) distant at 61 m (200 ft) is a clear warning to NATO interdictors.

Also from the Mikoyan-Gurevich design bureau, the MiG-29 'Fulcrum' joined its first operational regiment early in 1984. Of the combat aircraft now in Soviet service, the 'Fulcrum' may best be said to reflect the intense efforts made by the USSR to equal the West in aviation technology during the past decade. It has a new track-while-scan, long-range radar with pulse-Doppler look-down/shoot-down system, plus infra-red search and tracking, a head-up display and digital data-link to HQ.

A twin-engine aircraft having a thrust:weight ratio in the region of 1.1:1, the 'Fulcrum' is similar in size and weight to the McDonnell Douglas F/A-18 Hornet, and its agility in combat is reckoned to be close to that of the benchmark in modern fighter design, the General Dynamics F-16 Fighting Falcon. Armament is believed to comprise a 30-mm cannon and up to six AA-X-10 medium-range, terminally-guided AAMs, but may be changed for air-surface weaponry in the aircraft's secondary role. Here lies the strategy behind closer links between three once-separate tactical and air defence arms, for having swept an adversary from the skies in an initial onslaught, the Soviet air forces are designed to switch emphasis to ground attack to hasten the enemy army's collapse.

Imminent service-entry is expected of the Sukhoi Su-27 'Flanker', a larger (though no less manoeuvrable) interceptor which is viewed as the Soviet equivalent of the McDonnell Douglas F-15 Eagle. Naturally, it also has the latest radar and supporting avionics, together with eight AA-X-10s. It can detect targets at up to 240 km (150 miles) and track those within 185 km (115 miles) whilst still searching for additional contacts.

Improved co-ordination of these new interceptors against all low-level threats is being provided by the Ilyushin Il-76 'Mainstay', first examples of which are believed just to have entered service. The 'Mainstay' is an airborne early warning and control system (AWACS) similar in concept to the BAe Nimrod AEW.Mk 3 and Boeing E-3 Sentry, with the latter's 'saucer' rotodome. Able to remain on station for up to seven hours at a distance of about 1,500 km (930 miles) from base, it represents a considerable improvement over the existing Tupolev Tu-126 'Moss', whose overland detection capability is poor. Annual production of five 'Mainstays' is expected to result in a force of 30 by the end of the current decade, these having the ability to direct offensive operations as well as co-ordinate defence.

The gap through which Western aircraft could penetrate to maintain deterrence is closing rapidly as the Soviet Union translates technology into hardware at its own prodigious rate. Soon, the West's lead will be almost eliminated as the Voyska PVO deploys the new SA-10 SAM and the AA-XP-1 and AA-XP-2 AAMs further to increase its capability against the fast, low intruder. Security of the homeland remains the first objective of any air force, and it is clear from limited information available in the West that the Aviatsiya PVO is in the process of taking an immense step forward in that direction.

Current air defence version of the MiG-23 is the MiG-23MF, known to NATO as 'Flogger-G'. This differs from other versions by having a shorter dorsal fin, new sensors and a lighter radar. 'Flogger-Gs' have made several trips to Finland and France on friendship journeys.

Possessing variable-geometry, inflight-refuelling and Mach 2 capability, the Tupolev Tu-22M is the Soviet Union's principal strategic bomber. It is also employed on maritime duties, and several of the navy's 'Backfire-Bs' have posed for pictures over the Baltic. Escorted by a Swedish Draken, this 'Backfire' carries an AS-4 'Kitchen' missile.